UCR

University of California, Riverside
Riverside, California

DPP

Materials Science and Engineering
Detailed Project Program

May 30, 2003

HGA / KMW

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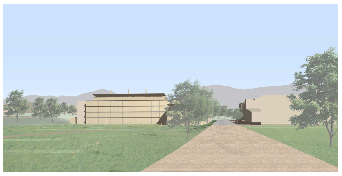
1.1 Overview

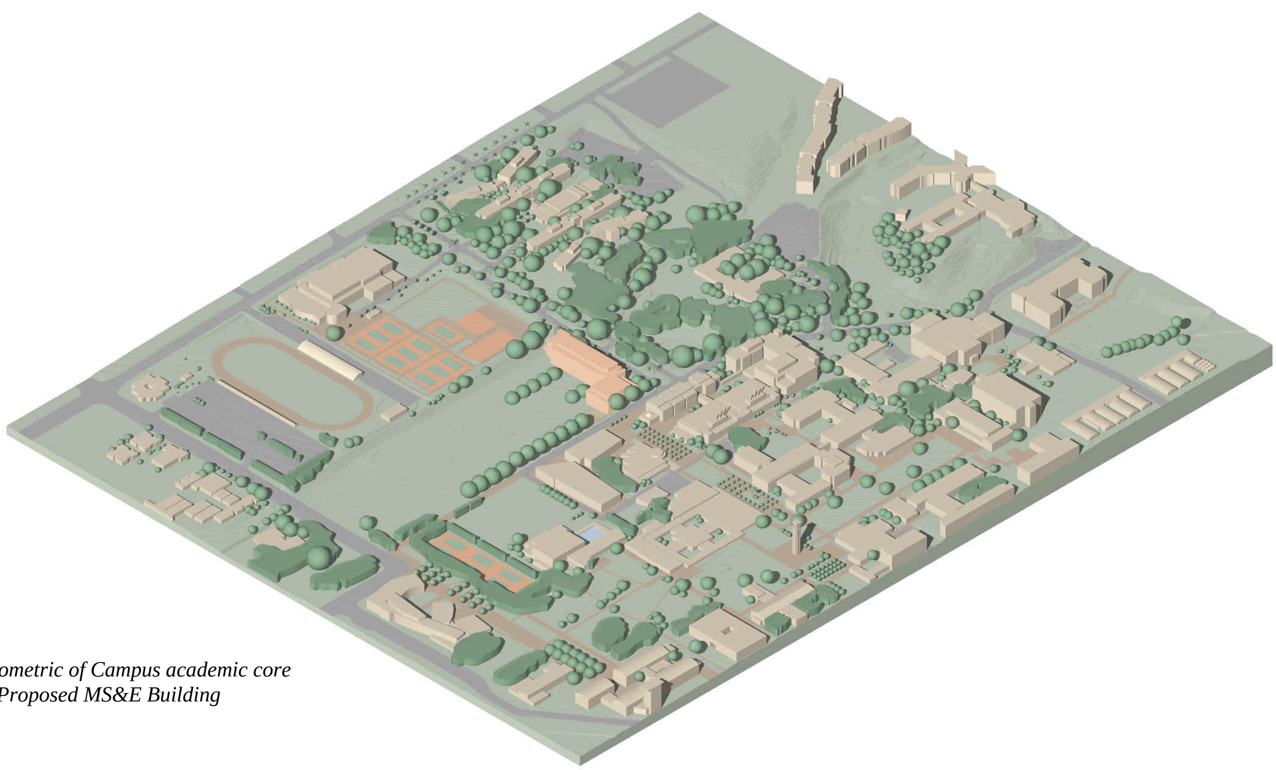


View East along North Campus Drive

This Detail Project Program (DPP) for The Materials Science and Engineering Building represents the cumulative results of various iterations of analyses presentations, workshops and focus groups to delineate the program objectives for the Bourns College of Engineering (BCOE) and the College of Natural and Agricultural Sciences (CNAS). The proposed Materials Science and Engineering Building will provide approximately 77,000 assignable square feet (asf) to accommodate the interdisciplinary instructional and research needs of the BCOE and the CNAS joint programs in nanotechnology, materials science, and bioengineering. In addition, the new Materials Science and Engineering Building will provide approximately 18,000 asf of general assignment classrooms for the Campus. This building would meet or exceed the requirements of Title 24 both in terms of sustainability and efficiency. The new facility with its program use is sited in accordance with the objectives of the LRDP.

The goal of the Materials Science and Engineering Building is to foster interdisciplinary research among faculty from both the College of Natural and Agricultural Sciences and the Bourns College of Engineering. The building represents a new model of scientific exploration at U.C. Riverside that crosses traditional college boundaries.

The project schedule anticipates completion of the related Project Planning Guide justification document in Spring 2003, construction is expected to start in early 2006, and occupancy of the facility is scheduled for 2008/2009.



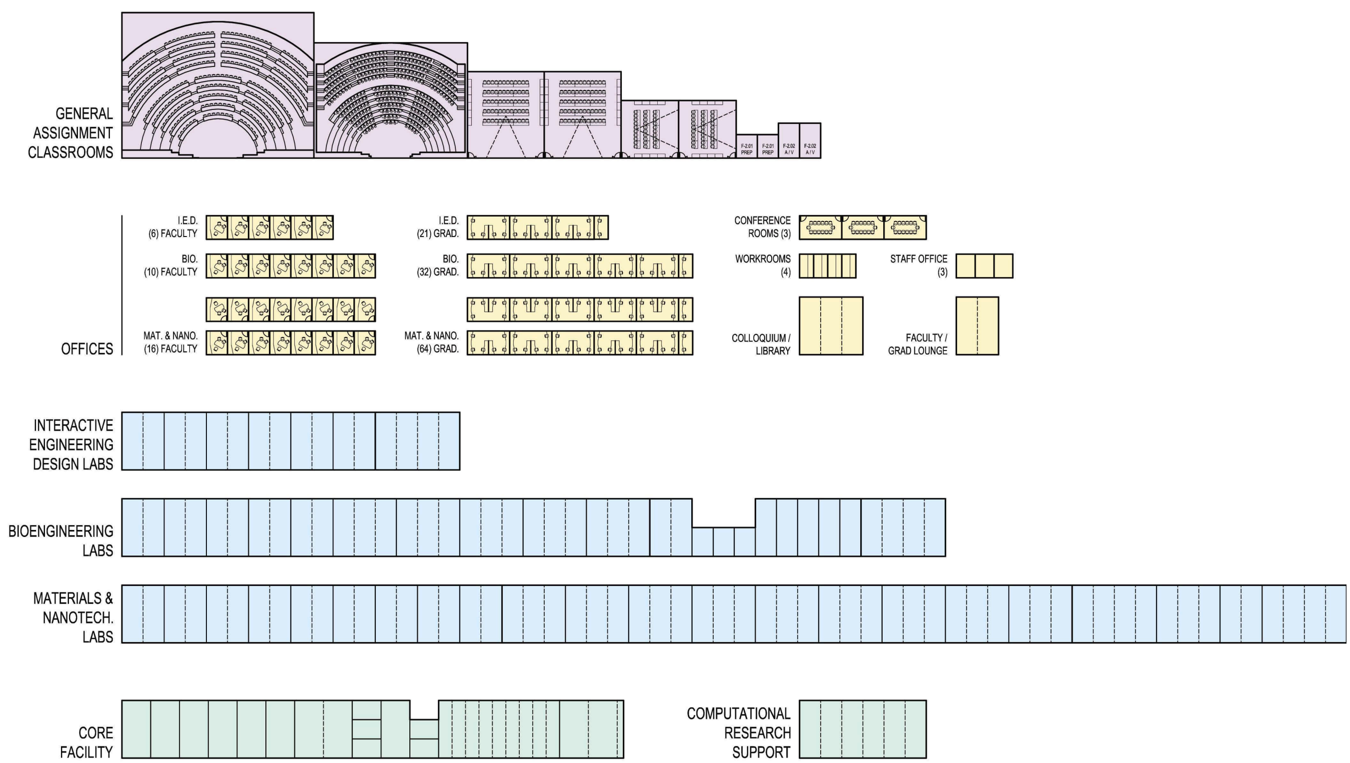
Axonometric of Campus academic core with Proposed MS&E Building

1.2 The Program

The following table and chart summarizes programmed space by type for the new Materials Science and Engineering Building:

SPACE PROGRAM

	ASF (Assignable Square Feet)
General Assignment Classrooms	18,370
Offices	5,850
Research & Instructional Laboratories	43,050
Core Facility	9,670
TOTAL PROGRAM (ASF) **Materials Science & Engineering**	**76,940**
TOTAL GROSS SQUARE FOOTAGE **Estimated at 57.4% efficiency**	**134,000**

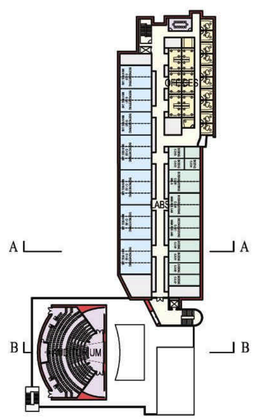


1.3 The Building

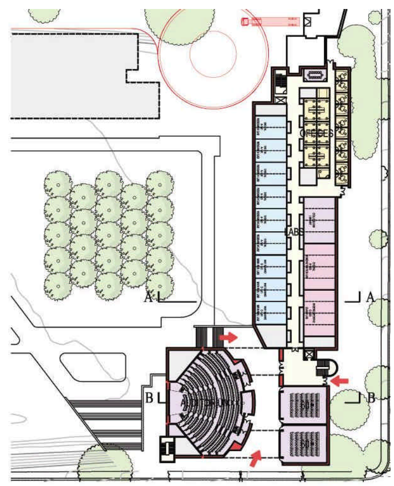
View South along Aberdeen Drive

The DPP developed an L-shaped building concept consisting of a 134,000 GSF facility with a four story lab building running north-south along Aberdeen Drive adjoining a three story classroom wing fronting North Campus Drive. The two building sections share an entrance lobby near the intersection of these two streets.

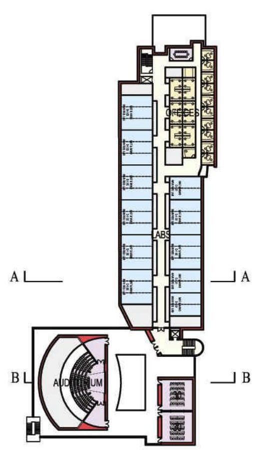
The laboratory planning concept shows a four story wing with instructional and research laboratories, lab support, and faculty offices evenly distributed on the upper three floors. The typical floor plate layout has laboratories spanning the entire length of the west side, and lab support or instructional labs opposite with faculty offices clustered into a collegial group on the north east side of this wing. The lower level houses the clean room core facility in addition to research laboratories with vibration sensitive equipment and requiring a greater ceiling height than available in the upper floors.



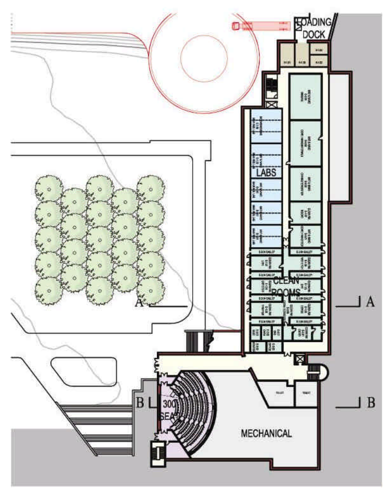
Third Floor



First Floor



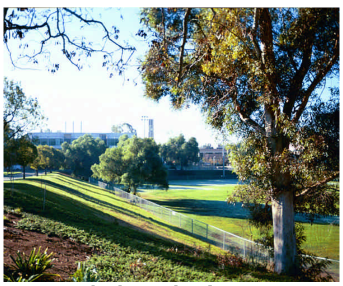
Second Floor



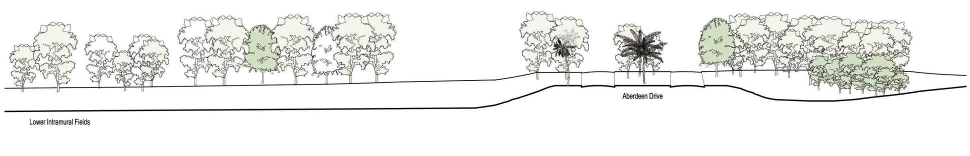
Lower Level

1.4 The Site

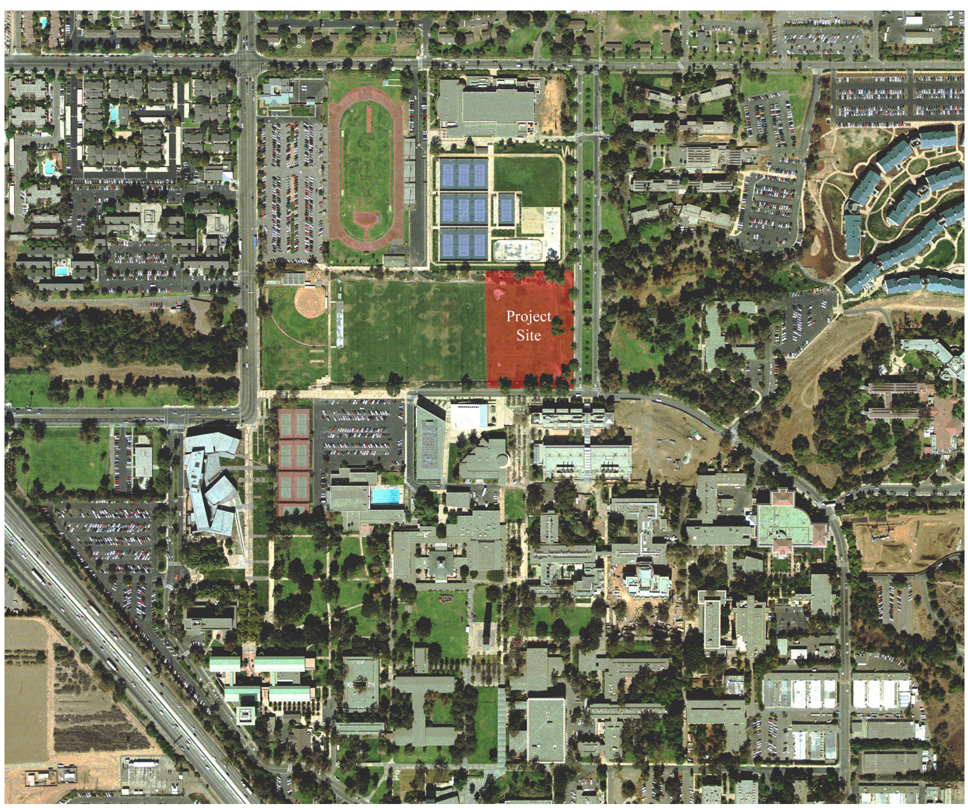

View East along North Campus Drive of Athletic Fields site


View South along Aberdeen Drive of Athletic Fields site

Through the process of analyzing several sites on the East Campus, (see 4.1 Site Options) it was determined that the most physically viable and programmatically appropriate site is the eastern portion of the Athletic Fields near the intersection of Aberdeen Drive and North Campus Drive. This site is in close proximity to the Physical Sciences faculty of the College of Natural and Agricultural Sciences and is adjacent to the Bourns College of Engineering. The site was also considered in terms of its adjacency to the campus academic core particularly with respect to the large student populations associated with the General Assignment Classroom components. The use proposed for this site and the strategy for campus expansion along with the role in fostering future development conforms to the guidelines proposed in the Long Range Development Plan for the Campus. The resultant building height and massing, projected pedestrian paths, required service access and potential utility connections were considered during the process.



West-East Site Section



Aerial View of Project site with surrounding Campus area

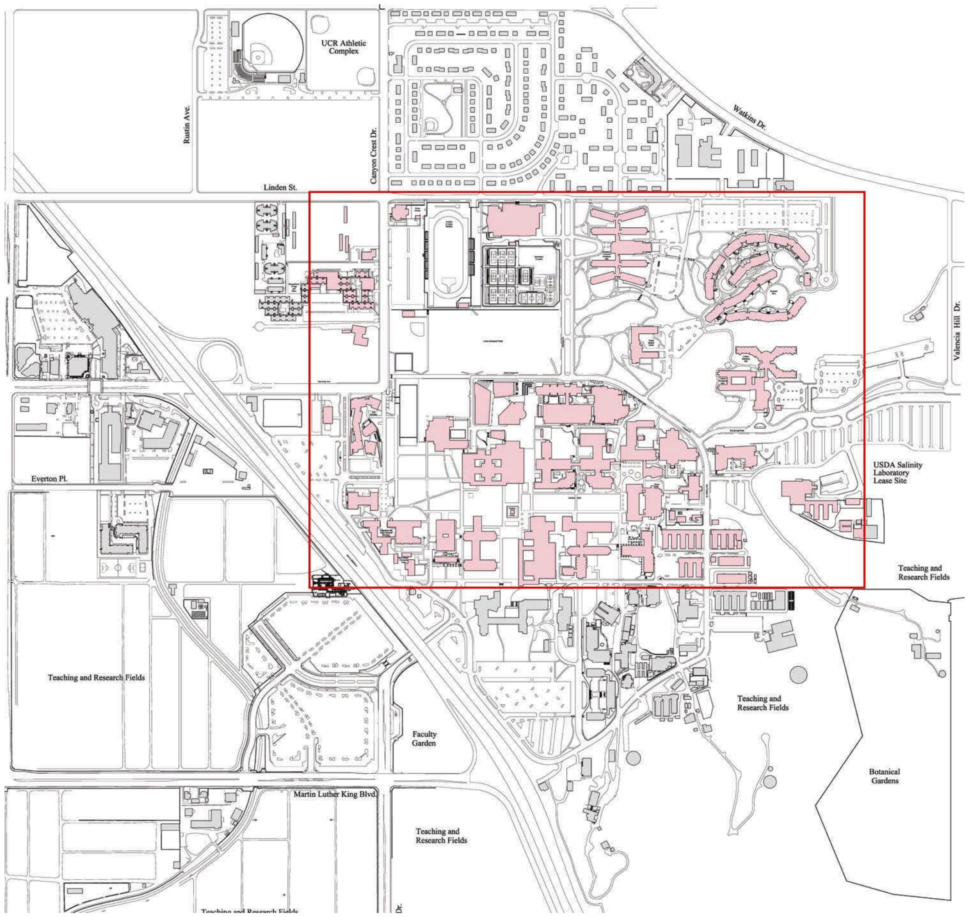
DPP

2.1 University of California Riverside

The University of California, Riverside was founded with an emphasis on high quality undergraduate instruction when the University of California established a College of Letters and Science at Riverside in 1954 as a small undergraduate liberal arts college. The campus was modeled in purpose and quality after the best private institutions in the East. Formal graduate instruction of a similar order began when UC Riverside was established in 1959 as a general campus of the University and authorized to offer graduate degrees. The origin of UC Riverside's commitment to high quality research and public service dates from the establishment of the Citrus Experiment Station in 1907, which developed into the Citrus Research Center and Agricultural Experiment Station.

The University of California, Riverside (UCR) is a 1,110-acre campus located three miles east of downtown Riverside in southern California's rapidly growing "Inland Empire" region, the one-time center of the citrus growing industry. This region has become one of the fastest growing areas of California. This growth has brought an increasingly diverse and multi-cultural population to the region, with concomitant diversity in business and industry development in the surrounding communities. UC Riverside serves as one of the most important major educational and cultural resources for this area. Most academic activities occur within the 576.5-acre campus area east of I-215/SR-60 freeway, with the remaining 533.5 acres west of the freeway used primarily for agricultural research and support programs.

The campus has entered a period of rapid enrollment growth, which is supporting its transformation into one of the premier public research university campuses in the United States. The campus had a total enrollment of 14,429 students (headcount) in Fall 2001 enrolled in 84 baccalaureate programs, 22 M.A. programs, 23 M.S. programs, an M.B.A. program, six types of educational credential programs, the first two years of medical school instruction, and 38 Ph.D. programs. The agricultural programs are integrated with the general campus programs in biological and physical sciences through the College of Natural and Agricultural Sciences (CNAS); the balance of the campus is organized into a College of Humanities, Arts and Social Sciences (CHASS); Bourns College of Engineering (BCOE); A. Gary Anderson Graduate School of Management (AGSM); a Graduate School of Education (GSOE); and a Biomedical Sciences Division. University Extension served 62,575 registrants during the 2001-02 academic year through courses in continuing professional education, general interest, recreation, matters of cultural and civic significance, and English as a Second Language.



Partial Campus map showing general area for DPP study

It is anticipated that the campus and its surrounding community can accommodate an enrollment of 25,000 students (headcount), with a ladder-rank faculty of approximately 1,184 FTE (full time equivalent) in 2015. The LRDP summarizes the ways in which the campus plans to manage future growth as it: encourages the achievement of greater excellence in existing college, schools and programs, including the arts, humanities, social sciences, natural sciences, and agriculture; develops additional professional schools; initiates new graduate and undergraduate degree programs; and develops additional areas of research specialization and community service.

2.2 Bourns College of Engineering (BCOE)


Bourns Hall

The Materials Science and Engineering building is somewhat unique in that it brings together under one roof research and faculty from two colleges; the Bourns College of Engineering (BCOE) and the College of Natural and Agricultural Sciences (CNAS).

The Bourns College of Engineering (BCOE) currently consists of four departments: Computer Science and Engineering, Electrical Engineering, Mechanical Engineering, and Chemical and Environmental Engineering. Within the four departments, instruction and research are pursued in the areas of air and water pollution control, biotechnology, automation and intelligent systems, smart materials, and communication networks. In all programs, design and implementation methods are emphasized in teaching. Interaction with leaders in related industries is encouraged.

The College places significant emphases on laboratory instruction. The capability to have the students connect theories learned in the classroom with hands-on experience in the laboratory is considered pivotal in the learning process. Similarly, design is an integral part of the curricula for all programs. Specifically, the senior design project courses for undergraduates are structured to provide the students with experience in developing solutions to “real world” engineering problems.


Bourns Hall

2.3 College of Natural and Agricultural Sciences (CNAS)

The College of Natural and Agricultural Sciences (CNAS) is unique among the nation's land grant universities in its integration of biological, agricultural, and physical sciences within a single college. Exclusive of its agricultural field stations, CNAS is comprised of 57 acres, situated on the east side of the campus. Most of the College's 14 major buildings range in age from 30 to more than 60 years, rendering them antiquated and unsuitable for 21st century science. Just as quality of space is a major concern for CNAS, so is quantity. Enrollment growth in the College is expected to keep pace with the rapid pace projected for the campus as a whole. By 2005-06, CNAS is projected to need an additional 125,875 asf to support its teaching and research programs.

The College of Natural and Agricultural Sciences is made up of 13 departments and three organized research units. These units are as follows:

- Biochemistry
- Biology
- Botany and Plant Sciences
- Chemistry
- Citrus Research Center – Agricultural Experiment Station
- Earth Sciences
- Entomology
- Environmental Sciences
- Genomics Institute
- Institute of Geophysics and Planetary Physics (IGPP)
- Mathematics
- Nematology
- Neuroscience
- Physics
- Plant Pathology
- Statistics

2.4 Program Summary

The Materials Science and Engineering Building will be the first major building at UC Riverside devoted to Nanotechnology research. "Nanotechnology represents the final frontier in miniaturization, at least on the surface of the planet," notes Robert Haddon, director of the Bourns College of Engineering Center for Nanoscale Science and Engineering. Nanotechnology offers a broad range of advances in science unheard of a few short years ago, and the Materials Science and Engineering Building will be the home of Nanotechnology research on the UC Riverside campus. Haddon further states:

"Nanotechnology is not confined to a particular field. It encompasses all of the scientific disciplines including chemistry, engineering, physics, biology, computers and medicine. Thus, Nanotechnology serves as a vehicle to create teams of scientists and engineers around a particular problem rather than focusing on what can be accomplished within a particular discipline. This comes about because the focus in Nanotechnology is on the basic building blocks of matter – atoms and molecules – and at that level all of the disciplines have a common starting point."

It is therefore the goal of the Materials Science and Engineering Building to foster interdisciplinary research among faculty from both the CNAS and the BCOE. It is intended that this building will represent a model of scientific exploration that crosses traditional college boundaries.

KEY PROGRAM COMPONENTS

The program for the Materials Science and Engineering Building will have components that will be shared by both CNAS and BCOE. Outlined below is a summary of the key elements of this program:

Materials Science & Nanotechnology

For several years, the CNAS has identified Materials Science as one of its core initiatives, and has consistently invested in this area. During the course of this development, a partnership with BCOE has emerged. The two colleges are eager to nurture this partnership, and hope to develop formal educational and research programs within Materials Science to the benefit of UC's mission. The proposed Materials Science and Engineering building will serve as a cornerstone to this partnership.

Materials Science is a major area of emphasis in Chemistry and Physics. In the long term, this research area will include a significant component in the biological sciences examining biomaterials. It is anticipated a strong alliance with the UCR Genomics Institute (UCRGI) will be formed. Therefore, Materials

Science is a stimulating impetus to enrich a large spectrum of basic science programs.

Materials capable of exhibiting active macroscopic behavior, termed as smart materials, are ideal for developing sensors and actuators, and when assisted with computation, communications, and control technologies, offer the potential of developing smart MEMS (micro-electromechanical systems). These technologies give unprecedented abilities: to create new materials; to test fundamental ideas about chemistry, physics, biology; and to bridge the gaps between the molecule-scale sciences and continuum-scale material sciences/engineering.

Nano-engineering refers to the technology that creates controllable structures on the molecular level using integrated circuit (IC) technology. While integrated circuit research was led by industry, nanoscale research is being led by universities. Less than two years ago the College of Engineering and the College of Natural and Agricultural Sciences jointly formed the Center for Nanoscale Science and Engineering which is headed by a Distinguished Professor of Chemistry and Chemical and Environmental Engineering. At present nearly 25 faculty members from all of the engineering disciplines as well as from cell biology neuroscience, chemistry and physics form the research team at the Center. This team is pursuing the control of charge, spin and light in nanoscale architectures to create a new set of electronic, photonic, spintronic and mechanical devices and systems.

The campus has made the initial resource commitments to make nanoscale science and engineering a core competency at UCR. UCR has also joined with UCLA and UCSB to form the Center for Nanoscience Innovation for Defense (CNID). This is a multimillion dollar Department of Defense funded alliance to facilitate a rapid transition of research innovation in the nanosciences into application for the defense sector. Since UCR is still in its beginning stages in nanotechnology, the CNID funds will help augment campus resources to create an intellectual environment where material engineers and scientists can collaborate.

Large investments in laboratory facilities and intensive faculty recruitment will be needed to create an unsurpassed competence in materials and nanotechnology. To stay competitive these investments are necessary. A small cleanroom nanofabrication facility to provide an initial capability in developing devices and processes is in the design phase and should be on-line in 2003-04. The facility will be housed in a renovated area in the Bourns Hall of Engineering.

Donated equipment to individual faculty members from the research team will be installed in this shared facility. The laboratories, large cleanroom, support areas, and faculty offices to be provided in the Material Science and Engineering Building will be required to keep pace with the developments in this rapidly evolving field. Both colleges will continue to recruit key faculty in the area of smart materials and nanotechnology; they will be located in this new building.

A graduate program in Materials Science and Engineering is being jointly formulated by both colleges. Although undergraduates may participate in research projects in this area, an undergraduate degree program is not currently envisioned.

Materials Science is approached from four different perspectives: *synthesis, characterization, fabrication* and *simulation.*

In ***synthesis***, the focus is on the production of materials with novel physical, chemical or geometrical properties such as semi-conductivity, super-conductivity or memories based on biological, chemical or physical characteristics. To achieve this end, the research involves manipulation of materials in different physical scales: from polymer through atoms to spinors. This applies to physical research of materials in biological medium: from plant cells to neuro-signals.

Characterization efforts complement and promote synthesis ability. Such efforts should seek the ability to develop sensors or instruments with rapid and simultaneous separation and analysis of chemical and biological agents in all states and in unusual environments. Beyond its academic value to basic science, characterization and instrumentation could develop into sensor technology with commercial, environmental, health and national security values.

When ***synthesis*** and ***characterization*** are combined, benefits are anticipated with device fabrication as small as nanometer scale to impact computing, DNA sequencing, proteomics and biomedical sciences.

In ***simulation***, goals include the application of modern computing capacity to predict materials behavior and to guide material synthesis. In addition, goals are set to advance a theory of fluid dynamics in nanoscale to make possible an advance from microfluidic device to nanofluidic device.

For device ***fabrication***, current research strengths are in microfluidic devices, molecular photonic devices, molecular memory and DNA memory. Device development will be driven by efforts in synthesis and characterization. Existing expertise in complexity modeling is in two different scales, namely fluid dynamics on astronomical scale and complexity in biological and chemical systems. To address needs in multi-scale interfacing, dynamics analysis must be promoted at the nanometer scale to complement our experimental program in Materials Science.

The focus of the entire program is in materials science within the scale from nanometer to cells, with an emphasis on interfacing among scales. The aspiration is to be pre-eminent in synthesis, characterization and fabrication within focused scale and in scale interfacing. The proposed building will provide a location for laboratories for new faculty, existing faculty who are key participants in this area, and modern instrumentation and clean room facilities for all UCR faculty, students and staff.

Bioengineering

The National Institute of Health defines bioengineering as*:*

"…the integration of physical, chemical, or mathematical sciences and engineering principles for the study of biology, medicine, behavior, or health. It advances fundamental concepts, creates knowledge for the molecular to the organ systems levels, and develops innovative biologics, materials, processes, implants, devices, and informatics approaches for the prevention, diagnosis, and treatment of disease, for patient rehabilitation, and for improving health"

Most of the top engineering schools in the country have a bioengineering program. The demand to couple engineering concepts to the burgeoning medical and healthcare fields continues to increase.

The College of Engineering is undertaking a bioengineering initiative which includes the establishment of a high quality research program that provides research opportunities for graduate and undergraduate students, develops a curriculum to prepare graduate and undergraduate students for a career in industry, academia and government, and attracts high quality students at graduate and undergraduate levels. This initiative will be multidisciplinary and involve other UCR colleges. Specific actions include:

- Introduce Bioengineering emphasis under the existing M. S. and Ph.D. programs in the BCOE beginning Fall 2004
- Introduce Bioengineering options under the existing B. S. programs in the BCOE beginning Fall 2004.
- Establish a stand-alone Bioengineering graduate program beginning Fall 2006
- Establish an independent Bioengineering department beginning Fall 2008.

The near-term focus will be on a graduate program. This program will build on the current research activities and interests of the UCR faculty in the bioengineering area.

- Sensors/Biosensors/Instrumentation
- Bioinformatics
- Bionanotechnology/BioMEMS
- Molecular Engineering of cardiovascular systems
- Electrophysiology
- Tissue (wound/skin healing) Engineering
- Biofluid Mechanics
- Bioimaging/Microscopy

Biosensors and Bioinformatics are our strongest areas and can be the initial focus of the UCR Bioengineering graduate program. The program will evolve through concentration on the specialties and faculty recruitment in:

- Sensors/Biosensors and instrumentation
- Bioinformatics/systems biology
- Biomaterials
- Tissue engineering
- Drug delivery
- Biofluid mechanics

Space in the Materials Science and Engineering Building is critical for the success of the programs in Bioengineering. The research laboratories, support areas, and faculty offices outlined in the DPP will be required to facilitate the interdisciplinary nature of this endeavor as well as accommodate the additional faculty and the extended research areas described earlier.

Interactive Engineering Design (IED)

As technology developments proceed at an ever increasing pace, the availability of devices utilizing digital technology is still an open question. The capability to design and test such devices, especially in the bioengineering and nanoscale engineering regimes requires a non-traditional approach. Dealing with issues such as user interfaces, human/machine interfaces, embedded device environments, etc demands an interactive engineering design methodology. Engineering design has benefited from computational tools such as computer-aided-design and simulation and modeling applications.

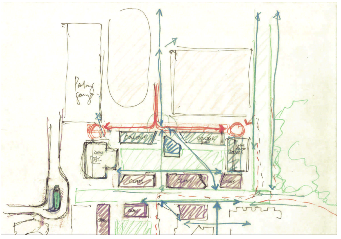
The use of computational techniques has led to increasingly popular term “in silico.” The term refers to “in or by means of a computer simulation.” This is based on the common terms used by biologists and biochemists….”in vivo” and “in vitro.” The concept for the Interactive Engineering Design (IED) Laboratories planned for the Materials Science and Engineering Building is to extend “in silico” to virtual testing and experiments using computational and visualization techniques. The process will “close the loop” between systems analysis and design, simulation and modeling, and testing and experimentation. The goal is to fill the gap between theory and experiment.

The capabilities to be provided in this area will allow: human interfacing with emphasis on interdisciplinary group interaction and collaboration; the study of how to transfer information; the capture of the complete practice of design, simulation, test, experiment, analysis, and redesign; creation of devices to foster interaction and testing of devices; and the communication of this new interactive paradigm for the closed loop process of engineering design.

The proximity of the IED Laboratories to the laboratories planned for Materials and Nanotechnology and Bioengineering researchers will provide a symbiotic relationship. As molecular-scale devices are conceived by these researchers virtual experiments can be conducted in the IED Laboratories to test their viability. Virtual tests and experiments are significantly cheaper and more timely than those conducted by conventional means. In addition to computational capability, these labs will have visualization facilities to provide for the virtual reality and motion modeling environment needed for the human interface for the engineering design process. These tools will extend the traditional static visualization provided by SEMs, TEMs, AFMs, etc to time dependent observations.

The research to be conducted in the IED Laboratories is envisioned to change the way engineering design is done and therefore how it is taught. The outcomes will necessarily be translated into modifications in the engineering curriculum.

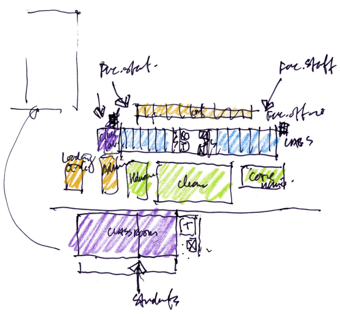
2.5 DPP Process



Early site analysis

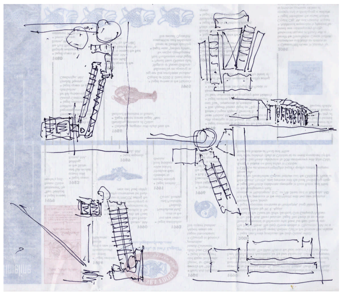
The DPP process officially began in late November 2002. The work effort extended over a 4-month period (18 weeks), concluding in mid-March of 2003. There were five workshops held to discuss the key aspects of scope, budget and schedule. The workshop agendas started with reviews of the basic program assumptions and proceeded through site planning considerations into conceptual building planning concepts. From these efforts, a comprehensive cost review was undertaken to evaluate goals and expectations against the established budget.

The "workshop" format was typically structured in one or two-day sessions which involved meetings with the following "Focus Group" representatives for the University:



Early program adjacency sketch

- Classroom Focus Group
- Computational Science Focus Group
- Materials / Nanotechnology & Clean Room Focus Group
- Bioengineering Focus Group
- Interactive Engineering Design Focus Group
- Campus Working Group



Early plan configuration studies

As is described in this DPP report, significant planning and refinement efforts were applied to the program to address the issue of budget compliance. This required the development of a meaningful understanding of the anticipated site design criteria as well as the delineation of reasonable architectural, structural and mechanical system assumptions. These guidelines formed the basis of the cost estimating process.

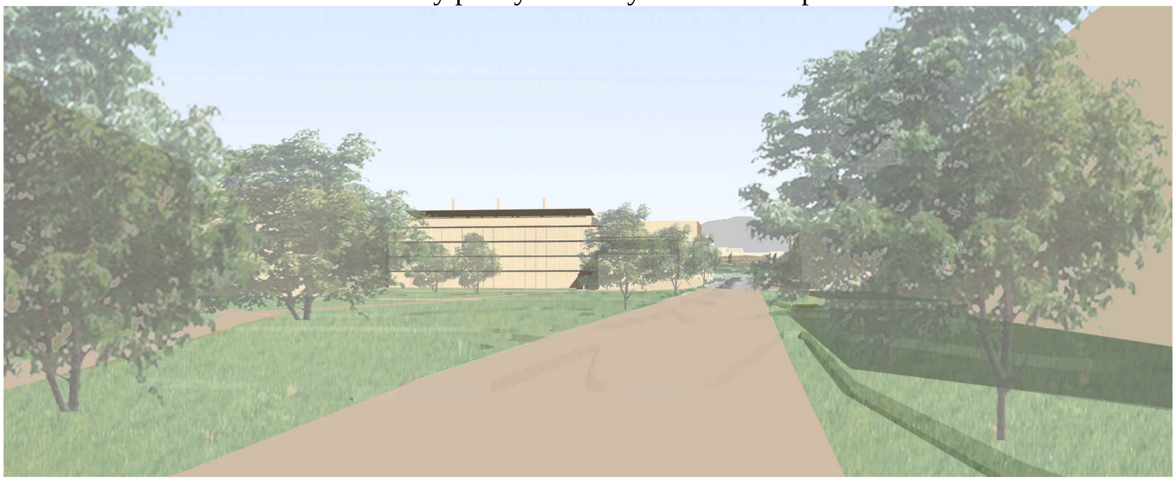
The conclusion to the phase included refinement to both the qualitative and quantitative expectations of the program. Such refinements reflected the primary goal of the DPP process – to define the detailed program requirements for the project, assuring that full coincidence was achieved between project scope, schedule and budget.

Meetings were established during each workshop session based on the primary agenda topics.

Goals and Objectives

In the process of developing a comprehensive program that will meet the University's instructional and research objectives, specific goals and objectives were distilled and adopted for the new Materials Science and Engineering Building:

- Establish the criteria for an optimally flexible laboratory facility with a functional and pleasant working environment including a clean room core facility which will foster the interdisciplinary exchange among the three primary research groups:
    - Materials and Nanotechnology
    - Bioengineering
    - Interactive Engineering Design
- Develop a flexible and fully accessible state of the art general assignment classroom facility for Campus wide instruction.
- Create an operationally efficient but distinctive building plan concept that will promote the necessary separation of the laboratory research functions from the instructional components.
- Generate a building plan that will maximize the salient conditions of the existing site while extending and enhancing the general arcadian character of the campus.
- Dispose the program elements in a manner that will promote the natural extension and expansion of the research activities and the need for subsequent future growth on this part of the campus.
- Explore the various opportunities to incorporate sustainable design features within the building. While some concepts can prove to be fairly costly, many do not and these will be integrated into the base design. Proposed concepts will be prioritized and with input from the Campus the team will select appropriate elements that fit within the confines of the project's budgetary allocations. Although LEED certification is not mandated for this project, one goal for the building will be to better California's Title 24 Energy Standards by at least 10 percent, or as defined by the Campus/University sustainability policy currently under development.



View along North Campus Drive towards the east

Program

3.1 Space Summary

The table below identifies the quantitative space needs in assignable square feet (asf) for the primary space types programmed to be in the new Materials Science and Engineering Building. As well, a projected estimate of the total gross square footage (gsf) based on a 57.4% multiplier. All of these quantities will need to be tested, verified, and re-evaluated in the early stages of the design process.

SPACE PROGRAM	No. of Modules	Area/ Module	Total ASF
Instructional			**20,020**
General Assignment Classrooms			17,700
Demonstration Classroom – 300 seats	*1*	*1*	*7,500*
Lecture Classroom – 300 seats	*1*	*4,800*	*4,800*
Classroom – 60 seats	*2*	*1,800*	*3,600*
Classroom – 30 seats	*2*	*900*	*1,800*
Classroom Support			670
Prep./storage	*2*	*135*	*270*
Auditorium control	*2*	*200*	*400*
Instructional Laboratory			1,650
Special Class Lab	*4*	*330*	*1,320*
Instructional Lab Prep	*1*	*330*	*330*
Offices			**5,850**
Offices			4,050
Faculty Offices	*30*	*135*	*4,050*
Academic Support Spaces			1,800
Staff Offices	*3*	*120*	*360*
Open Office/Work Area	*4*	*90*	*360*
Conference Room	*3*	*270*	*810*
Mailroom	*1*	*135*	*135*
Storage	*1*	*135*	*135*

SPACE PROGRAM (continued)

	No. of Modules	Area/ Module	Total ASF
Research			**41,400**
Research Labs			33,645
Research Labs	*86*	*330*	*28,380*
Graduate Students/Post Doc	*39*	*135*	*5,265*
Shared Research Support Space			6,105
BSL-3	*2*	*330*	*660*
Autoclave/Ice Machine	*0.5*	*330*	*165*
Environmental Room	*0.5*	*330*	*165*
Microscopy	*0.5*	*330*	*165*
Shared Equipment	*4*	*330*	*1,320*
Imaging Lab	*4*	*330*	*1,320*
Characterization Lab	*3*	*330*	*990*
Computational Laboratory	*3*	*330*	*990*
Receiving/Chemical Storage	*1*	*330*	*330*
Scholarly Activity			1,650
Faculty / Grad. Student Lounge	*2*	*330*	*660*
Library/ Colloquium	*3*	*330*	*990*
Core Facility (Clean Room)			**9,670**
Clean Room			5,580
Lithography	*1*	*450*	*450*
Wet Etch	*1*	*450*	*450*
Diffusion/Annealing	*1*	*450*	*450*
Dry Etch	*1*	*450*	*450*
Deposition	*1*	*450*	*450*
Thin Film	*1*	*450*	*450*
MOCVD	*2*	*450*	*900*
Core/Nanotechnology Lab	*2*	*330*	*660*
Core/Nanomaterials Lab	*4*	*330*	*1,320*
Clean Room Support			4,090
Gas Storage	*0.33*	*450*	*150*
Chemical Storage	*0.33*	*450*	*150*
Electronics Shop	*0.33*	*450*	*150*
Entry/Gowning	*1*	*450*	*450*
Monitor/Controls	*0.33*	*450*	*150*
Office	*0.33*	*450*	*150*
Service Galley	*9*	*210*	*1,890*
Clean Corridor	*2.22*	*450*	*1,000*

TOTAL PROGRAM (asf)
Materials Science & Engineering **76,940**

TOTAL GROSS SQUARE FOOTAGE (gsf)
Estimated at 57.4% efficiency **134,000**

3.2 Master Space List by Program Area

SPACE PROGRAM	No. of Modules	Qty	Module ASF	Total ASF
A. Materials and Nanotechnology				**19,140**
1.0 Laboratories				
1.01 Main Research Lab	*2*	*9*	*330*	*5,940*
1.02 Main Research Lab	*3*	*7*	*330*	*6,930*
1.03 Synthetic Chemistry Research	*3*	*2*	*330*	*1,980*
2.0 Support				
2.01 Support Imaging	*4*	*1*	*330*	*1,320*
2.02 Support Characterization	*3*	*1*	*330*	*990*
3.0 Shared / Other				
3.01 Core / Nanobiotechnology	*2*	*1*	*330*	*660*
3.02 Core / Nanomaterials	*4*	*1*	*330*	*1,320*
B. Clean Room Core				**7,690**
1.0 Laboratories				
1.01 Lithography	*1*	*1*	*450*	*450*
1.02 Wet Etch	*1*	*1*	*450*	*450*
1.03 Diffusion / Annealing	*1*	*1*	*450*	*450*
1.04 Dry Etch	*1*	*1*	*450*	*450*
1.05 Deposition	*1*	*1*	*450*	*450*
1.06 Thin Film	*1*	*1*	*450*	*450*
1.07 MOCVD	*2*	*1*	*450*	*900*
2.0 Support				
2.01 Gas Storage	*0.33*	*1*	*450*	*150*
2.02 Chemical Storage	*0.33*	*1*	*450*	*150*
2.03 Electronics Shop	*0.33*	*1*	*450*	*150*
3.0 Shared / Other				
3.01 Entry / Gowning	*1*	*1*	*450*	*450*
3.02 Monitor / Controls	*0.33*	*1*	*450*	*150*
3.03 Office	*0.33*	*1*	*450*	*150*
3.04 Service Galley	*1*	*9*	*210*	*1,890*
3.05 Clean Corridor	*2.223*	*1*	*450*	*1,000*

SPACE PROGRAM (continued)

		No. of Modules	Qty	Module ASF	Total ASF
C. Bioengineering					**12,375**
1.0 Laboratories					
1.01	*Main Research Lab*	*2*	*5*	*330*	*3,300*
1.02	*Main Research Lab*	*3*	*5*	*330*	*4,950*
2.0 Support					
2.01	*BSL-3*	*2*	*1*	*330*	*660*
2.02	*Autoclave / Ice Machine*	*0.5*	*1*	*330*	*165*
2.03	*Environmental Room*	*0.5*	*1*	*330*	*165*
2.04	*Microscopy*	*0.5*	*1*	*330*	*165*
3.0 Shared / Other					
3.01	*Shared Equipment*	*1*	*2*	*330*	*660*
3.02	*Shared Instrumentation*	*1*	*2*	*330*	*660*
3.03	*Class Lab*	*4*	*1*	*330*	*1,320*
3.04	*Instruction Prep*	*1*	*1*	*330*	*330*
D. Interactive Engineering Design					**5,280**
1.0 Laboratories					
1.01	*Research Lab*	*2*	*6*	*330*	*3,960*
1.02	*Demonstration Lab*	*4*	*1*	*330*	*1,320*
E. Offices and Academic Support					**13,485**
1.0 Faculty Offices					
1.01	*Digital Learning*	*1*	*6*	*135*	*810*
1.02	*Bioengineering*	*1*	*8*	*135*	*1,080*
1.03	*Materials / Nanotechnology / Comp.*	*1*	*16*	*135*	*2,160*
2.0 Academic Support					
2.01	*Staff Office*	*1*	*3*	*120*	*360*
2.02	*Faculty / Grad Office*	*1*	*2*	*330*	*660*
3.0 Graduate Students					
3.01	*Interactive Engineering Design*	*1*	*21*	*45*	*945*
3.02	*Bioengineering*	*1*	*32*	*45*	*1,440*
3.03	*Materials / Nanotechnology / Comp.*	*1*	*64*	*45*	*2,880*
4.0 Shared / Other					
4.01	*Conference room*	*1*	*3*	*270*	*810*
4.02	*Work Rooms*	*0.66*	*4*	*90*	*360*
4.03	*Colloquium Library*	*3*	*1*	*330*	*990*
4.04	*Computational Research Support*	*3*	*1*	*330*	*990*

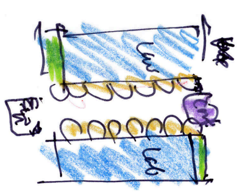
SPACE PROGRAM (continued)

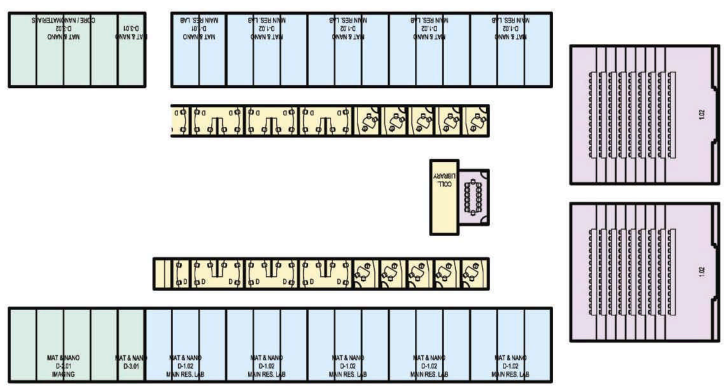
	No. of Modules	Qty	Module ASF	Total ASF
F. General Assignment Classrooms				**18,370**
1.0 Classrooms				
1.01 Demo Auditorium (300 seats)	*1*	*1*	*7,500*	*7,500*
1.02 Lecture Auditorium (300 seats)	*1*	*1*	*4,800*	*4,800*
1.03 Medium Classroom (60 seats)	*1*	*2*	*1,800*	*3,600*
1.04 Small Classroom (30 seats)	*1*	*2*	*900*	*1,800*
2.0 Support				
2.01 Prep / Storage	*1*	*2*	*135*	*270*
2.02 Auditorium Control Room	*1*	*2*	*200*	*400*
G. Building Support				**600**
1.0 General Support				
1.01 Shipping / Receiving	*1*	*1*	*330*	*330*
1.02 Mailroom	*1*	*1*	*135*	*135*
1.03 Storage	*1*	*1*	*135*	*135*

TOTAL PROGRAM **76,940**

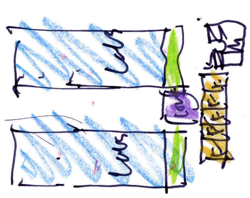
3.3 Program Blocking Diagrams

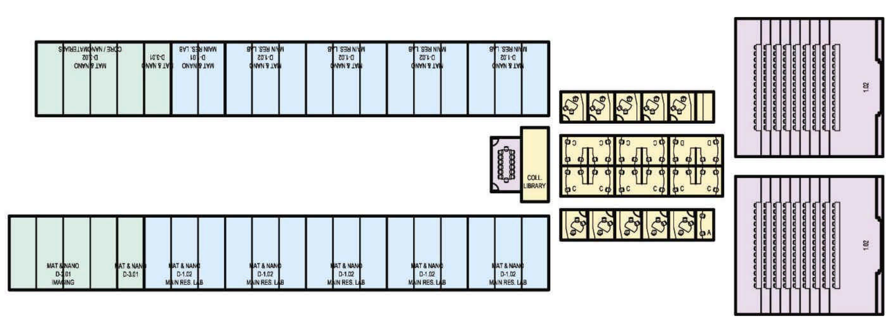
The DPP process investigating various strategies for the disposition of program space types on a typical floor as well as general configurations for the classrooms and core facilities as they relate to a typical floor. A primary consideration for the research component is the attempt to plan, for any kind of laboratory, on the typical floors would be able to accommodate any type of research endeavor, and that in a truly inter-disciplinary mode, multiple disciplines could be based together on any given floor.



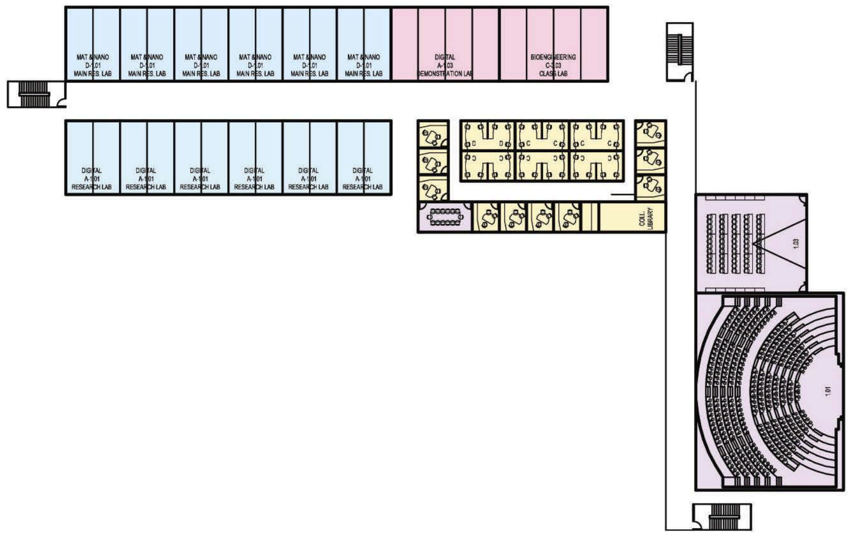


1. *faculty office cloister/ single loaded laboratories*

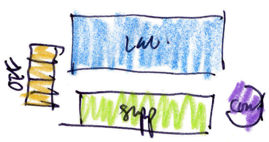


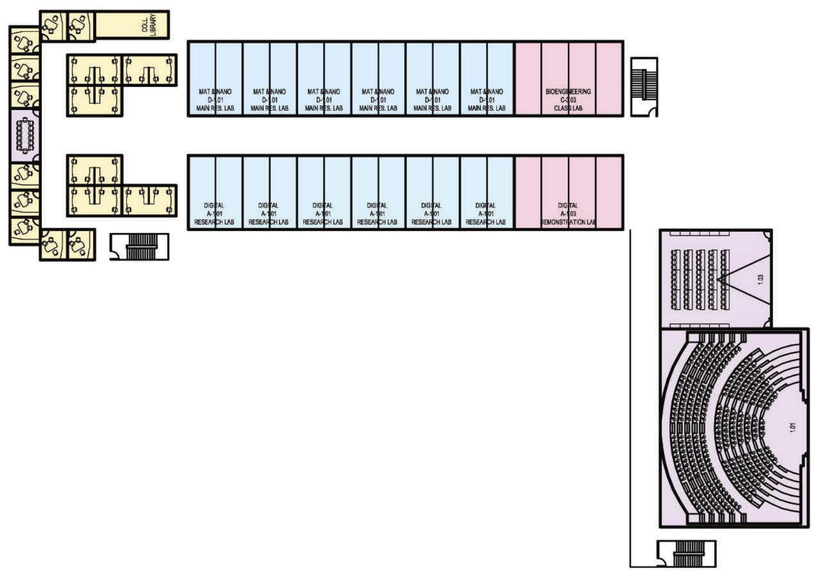


2. *faculty office intermediate zone / double loaded laboratories*

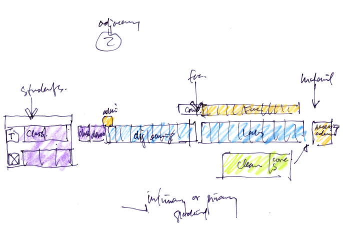


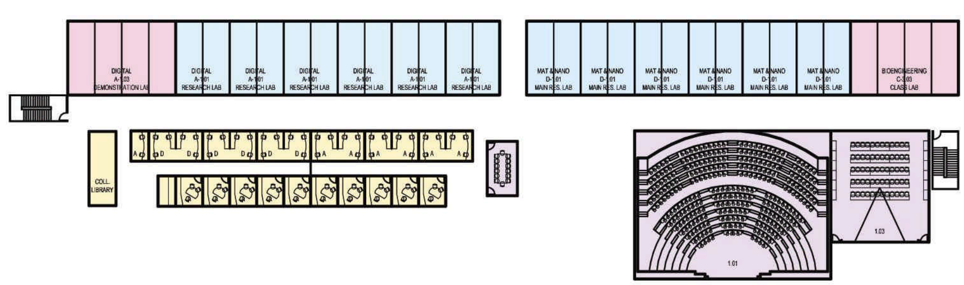
3. *faculty office cluster intermediate zone / double loaded laboratories*





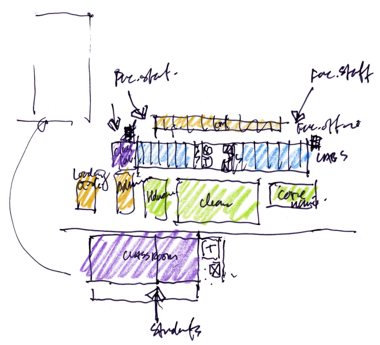
4. *faculty office remote / double loaded laboratories*



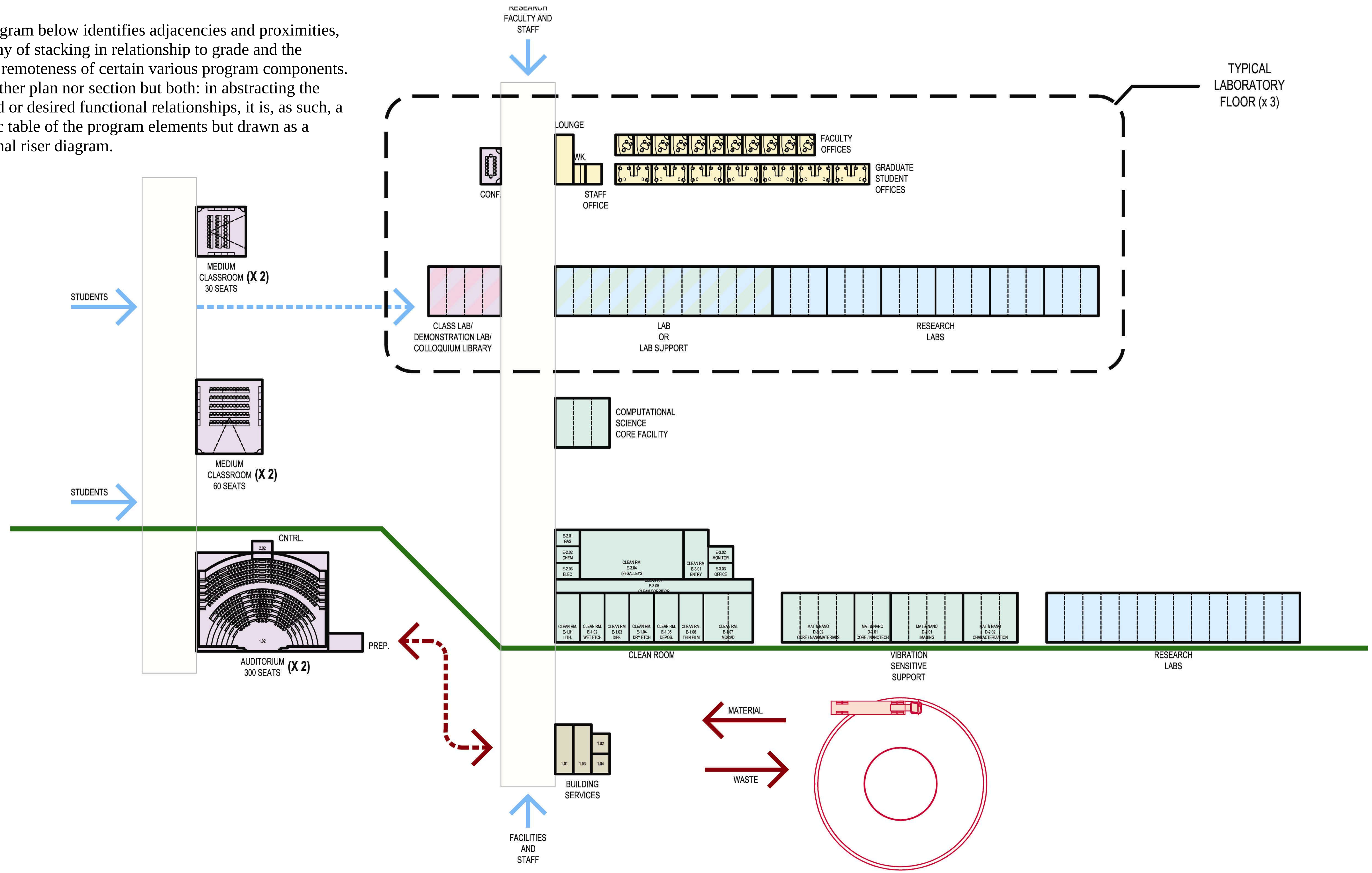


5. *faculty office array / single loaded laboratories*

3.4 Program Relationships



The diagram below identifies adjacencies and proximities, hierarchy of stacking in relationship to grade and the desired remoteness of certain various program components. It is neither plan nor section but both: in abstracting the required or desired functional relationships, it is, as such, a periodic table of the program elements but drawn as a functional riser diagram.



3.5 Building Efficiency

Building efficiency is described as the relationship (ratio) of the assignable area in a building to the total gross area. It is typically defined as a percentage obtained by dividing the assignable area by the gross area (asf/gsf). Efficiency can also be expressed as a multiplier of the assignable area, which is derived by reversing the ratio elements (gsf/asf).

The most common basis of reference for efficiency calculations is the 1964 Technical Report No. 50, "Classification of Building Area," produced by the National Academy of Sciences, National Research Council. The definitions contained in the report have since served as a common basis of reference. More specific to this project is the following guideline document:

- Appendix C, entitled ***Building Area Overview*** of the Supplemental Requirements dated January 1, 1996 to the "University Standard Form of Agreement between the Regents of the University of California and the Architect."

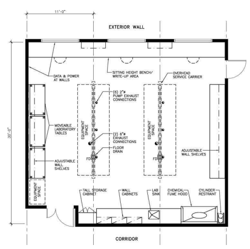
Much discussion was held during the DPP phase regarding the numerical value of the efficiency ratio for this project. Extensive evaluation was undertaken relative to similar building types and comparable projects. As the net/gross factor represents a significant attribution of square footage to any project, it correspondingly represents a major cost element in a project's initial budgeting. After significant study, a factor of approximately 57% was established for the cost/program reconciliation based on the gross square footage of the planning approach diagrams.

3.6 Space Types

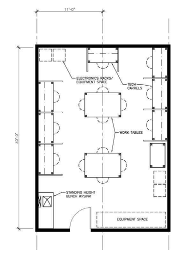
The general overview of the functions listed in the program summary is designated into the following four categories with a brief description of each.

Research Laboratories

Comprising the majority of space in the building, all three of these laboratory types reflect the primary design goal of providing for a flexible and adaptable interdisciplinary research environment. Based on principles of modular planning they are of standardized dimensions and units and are thus intentionally generic, but with latitude of using fixed benchwork or movable tables.



Materials and Nanotechnology



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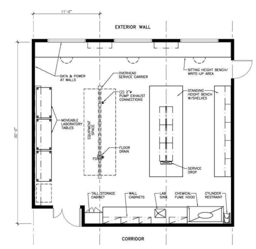
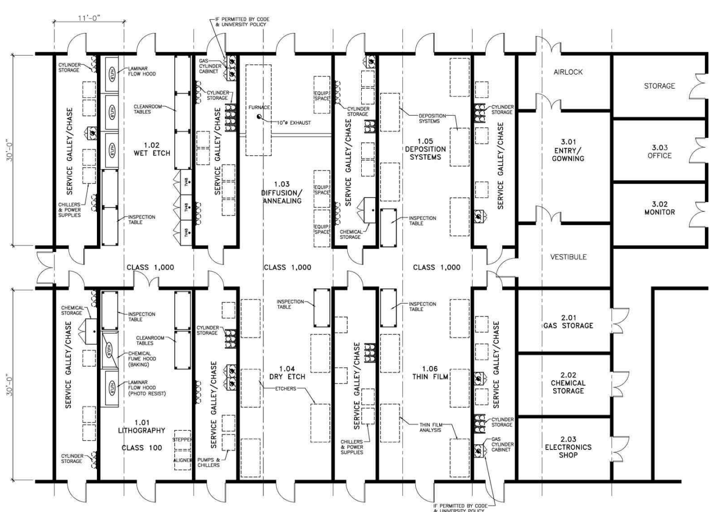


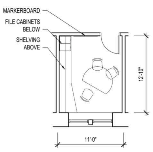
Biology

Clean Room Core

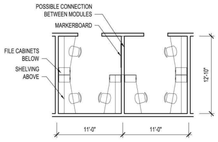
This suite will provide a unique research environment in the areas of semi-conductor, materials and nanomaterial processes and bioelectronics fabrication. The equipment bays will provide the prescribed performance demands for lithography, wet etch, diffusion/annealing, dry etch, deposition and thin film. The space will include an airlock and separate gowning area and there will be no less than one service chase or galley for each clean room module. Separate, non-clean space dedicated for monitoring, chemical storage and gas cylinder storage will be provided.



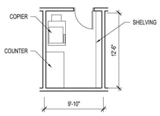
Clean Room



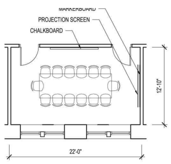
Faculty Office



Grad Office



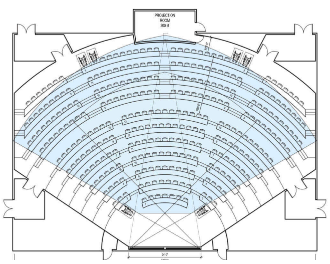
Work Area



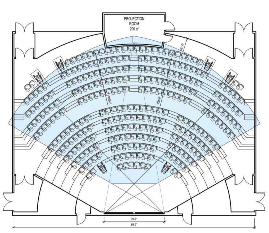
Conference Room

Offices

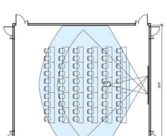
The interdisciplinary character of this research and instructional facility supports the need for standardized faculty and graduate student office spaces and support. While fixed quantities of offices are associated with the three areas of research (i.e: Materials and Nanotechnology, Bioengineering, and Interactive Engineering Design), the modular nature of these elements is planned to promote increased flexibility for fluctuations in the population of researchers. Thus, the basic 135 ASF planning module can be a faculty office or a shared office for three graduate students at 45 ASF each. Larger aggregates of these units can be planned as open offices for grad students, work areas, conference rooms, or any combination thereof.



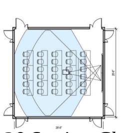
300 Station Demonstration



300 Station Lecture



60 Station Classroom



30 Station Classroom

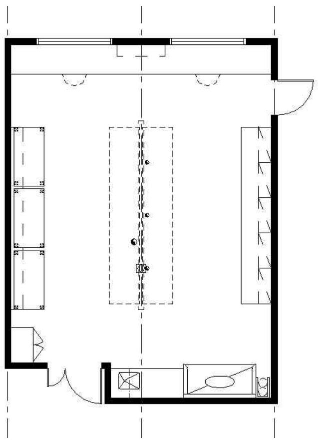
General Assignment Classrooms

The General Assignment Classrooms will provide a substantial group of state of the art instructional spaces of the appropriate mix of classroom space types. These will address the urgent need on campus for University wide teaching facilities and reinforce the importance of the educational mission which embodies the various types of interaction whether formal instruction, spontaneous breakout, or interactive collaboration. The specific program components are as follows:

- (1) 300 station Demonstration-type stepped floor classroom
- (1) 300 station Lecture-type stepped floor classroom
- (2) 60 station flat floor classrooms
- (2) 30 station flat floor classrooms

The Demonstration-type classroom will include process utilities and exhaust capabilities (instruction table only) and fixed seats and tables. The 300 station Lecture-type classroom will have fixed seats with tablet arms. All classrooms are programmed to be provided with the electrical/data infrastructure to support multi-media instruction. More detailed diagrams and technical criteria are included in Appendix I – Room Data Sheets.

3.6.1 Laboratory Criteria



Initial meetings with the Deans and faculty of the colleges of *Engineering* and *Natural and Agricultural Sciences* underscored the interdisciplinary character of the Materials Science and Engineering Building. Although the actual occupants are not known at this time, the overall program of the building was organized into the following major focus groups:

Materials and Nanotechnology
Bioengineering
Digital Learning
Cleanroom Core

Subsequent focus group meetings were held to develop enough detail to generate functional requirements which then could be documented as diagrams and data sheets. The next step was to look for common elements to develop a laboratory design concept that responds holistically to the interdisciplinary character of the building program. While each group has unique issues influencing the design of the respective laboratories, this integrative step sought to coalesce as many common characteristics as possible in order to promote programmatic flexibility, particularly between *Materials and Nanotechnology* and *Bioengineering* laboratories.

The diagrams and data sheets were revised to reflect this process and are included in Appendix 1.

Laboratory Design: General Approach:

Materials and Nanotechnology / Bioengineering. Comprising the majority of laboratory space in the building, approximately 31,100 ASF, these laboratories reflect the primary design goals of providing a flexible and adaptable environment for an interdisciplinary and varied research program. While the functional engineering criteria is slightly different (See Functional Criteria) for the two focus groups, it is anticipated that overlap will occur as programs, occupancies, and instrumentation requirements evolve.

To this end, potentially fixed benchwork in the main research laboratories is concentrated in the vicinity of fume hoods and along one side wall of the labs. With the exceptions of the synthetic chemistry portion of the material and nanotechnology and option ‘C’ of Bioengineering, (see room layouts and data sheets in Appendix I), the center of the labs are kept free for movable tables and freestanding instrumentation. Overhead service carriers are provided allowing connections of instrumentation to electrical power and other centralized utilities. This does not preclude the addition of fixed benchwork in the future. Utilities along the walls should be distributed independently of the fixed benchwork to allow for future additions or removal of the benchwork as well as adding utilities without requiring costly renovations.

With the proper utilities distribution concept as described above, conventional benchwork with cabinetry that is that is floor supported can be effectively utilized. However, it is recommended that other types which are more easily relocated be investigated during the schematic design phase.

To the extent possible, fume hoods and major sinks are located against the corridor side of the laboratories, thus facilitating the economic removal of intervening partitions.

While the main research laboratories described above are intentionally generic in design, support spaces such as ‘imaging’ and ‘characterization’ in the *Materials and Nanotechnology focus group* and ‘autoclave’, ‘microscopy’, ‘environmental room’, ‘BSL-3 Lab’ and ‘shared equipment’ in the *Bioengineering* are designed to specifically accommodate their unique requirements. These support laboratories will be co-located with the main research laboratories.

See the Functional Criteria, Table 1, as well data sheets and diagrams (Appendix 1) for additional programming level definition of the *Bioengineering and Materials and Nanotechnology* laboratories.

Clean Room Core. This area of approximately 7,700 ASF will provide a unique environment for conducting research in the areas of semiconductor and nanomaterial processes and materials. The equipment bays will provide the cleanliness, vibration, exhaust and other utilities for lithography, wet etch, diffusion/annealing, dry etch, deposition, and thin film.

These equipment bays will be flanked by service galleys through which the centralized utilities, such as cooling water, special exhaust), nitrogen, compressed air and electrical power and data connections will be distributed, and valved / capped. The galleys will also house ancillary equipment such vacuum pumps, secondary heat exchangers, gas cylinders, and gas cabinets (subject to university and code restraints).

The clean room tool bays will be designed to Class 1000 with the exception of the lithography area which will be designed at class 100. The addition of laminar flow shrouds at particular locations can be expected to increase the class designation by one order of magnitude should a specific equipment or process require.

The clean room suite is surrounded by exit corridors which function as secondary safety egress for each tool bay and service galley. The suite should be located as close as possible to the loading dock with a dedicated materials supply route. At this time, the final determination of the code classification for the suite has not been determined, but the use of exit corridors and a dedicated materials supply route is prudent and permits flexibility in responding to the letter and spirit of different code classifications.

At this time, it is anticipated that there will be multiple exhaust systems for the clean room suite: wet process hoods, tool, vacuum pumps, and gas cabinets. Scrubbers, if required, will be provided locally as part of the equipment fit-up.

Gas detection and alarm systems will be designed and installed as part of the construction project.

Gas cabinets required for certain specialized gases are likely to be required by the university environmental health and safety representatives or by accepted practice. Due to the nature of academic research it is difficult to determine during programming exactly how many and for which gases they are required. However, for planning purpose, it is estimated that between five and seven may be an appropriate number.

Expansion to the clean room suite can be made by adapting the contiguous Nanotechnology core and Metallic-Organic Chemical Vapor Deposition (MOCVD) lab to clean room conditions. The capacities of the initial clean room and building HVAC, process utilities and electrical power systems should take this potential into account.

See the Functional Criteria, Table 1, data sheets and diagrams for additional programming level definition of the *Clean Room Core*.

Interactive Engineering. The 5,300 asf of laboratory space in this research area will accommodate research related to the interaction between engineering and the digital process. The laboratories need to be highly flexible in order to adapt to quickly evolving and oftentimes unpredictable programmatic directions. Movable tables will largely supplant fixed benchwork and a metal grid system will be suspended from the structure above to facilitate relocation of utilities as well as permit modifications to localized lighting.

These spaces are not expected to use chemicals and will not require fume hoods or other exhaust extraction devices or systems. At this time it is anticipated that these laboratories can be operated on a recirculating HVAC system if the location affords economic justification.

Although these laboratories will not require many of the process utilities needed in the *Bioengineering, Materials and Nanotechnology and Clean Room Core* laboratories, electrical power loads and therefore cooling loads will be high.

See the Functional Criteria Section, Systems ,Table 1, data sheets and diagrams for additional programming level definition of the *Interactive Engineering* laboratories.

3.6.2 Functional Criteria

Table 1 below, indicates the program level estimates of required centralized utilities to the various laboratory types. The requirements are expressed on a modular basis (see Modular Planning). It is anticipated that some refinement of these requirements will occur during further design phases.

It is recommended that the HVAC system be designed to anticipate an expansion of the fume hood exhaust system by 15-20% over the life of the building.

For distribution of data outlets, refer to the Electrical section (6.2).

TABLE 1

Functional Criteria

	Central Utilities										
	Water				Compressed Air	Nitrogen gas	Electrical		Cooling Water		
Laboratory Type	**Industrial IHWICW**	**Potable for Safety stations**	**Pure Water PW**	**High Purity HPW**	**CA (scfm)**	**N2 (scfm)**	**120/208v**	**480 v**	**CEWS/R**	**Fume Exhaust**	**BTU/h**
Bioengineering (NSFL = 12,045)	1 sink/3 mod	Incidental use, 20 gpm/ station	1 sink/3 mod	0	3/mod	0.5/mod	30-40w/sf	0	1 gpm/mod	1.5 cfm/sf	25-30/sf
Nanotechnology (typical) (NSFL = 17,160)	1 sink/3 mod	Incidental use, 20 gpm/ station	1 sink/3 mod	0	5/mod	1/mod	35-45w/sf	0	3 gpm/mod	2.0 cfm/sf	25-30/sf
Nanotechnology (Synthetic Chemistry) (NSFL = 1,980)	4 sink/3 mod	Incidental use, 20 gpm/ station	4 sink/3 mod	0	5/mod	1/mod	25-35w/sf	0	3 gpm/mod	3.0 cfm/sf	20-30/sf
Clean Room (including service galley) (NSFL = 6,690)	0	Incidental use, 20 gpm/ station	0	120 gal/day	20/service galley	5/service galley	50-60w/sf	100 amps	6 gpm/ CRmod	4-5 cfm/sf	90-100/sf
Interactive Engineering (NSFL = 5,280)	1 sink/2 mod	Incidental use, 20 gpm/ station	0	0	0	0	25-30w/sf	0	0	Recirc.	30-40/sf

Notes & Abbreviations
mod = Laboratory module (330sf)
CRmod = Clean room module (450sf)
NSFL = Net Square Foot of Laboratory

Clean Room loads include:
Tool space
Service galleys
Support rooms

Clean Room loads exclude:
Internal clean room corridor

Note: All loads are connected without applied diversities.

3.6.3 Sustainability

The development of an effective sustainability strategy for the laboratory portions of the Materials Science and Engineering Building will require a constant investigation and evaluation of potential measures. In general these measures fall into two categories: (1) materials processing and (2) energy conservation. Suggestions for further investigation include:

(1) Materials Processing
- Wood from “Certified Sustainability Managed Forests”
- Minimum requirements for recycled steel content
- Use of Environmentally ‘friendly’ finishes:
  Water-borne application for wood
  Finishes applied with ‘near-zero’ VOC emissions
  No ‘offgasing’ of wood products after curing
  Dry coating process for steel casework finishes

(2) Energy Conservation
- Variable Air Volume (VAV) control systems on fume hoods
- Sash-limiting devices on fume hoods to reduce air flow
- Occupancy sensor for fume hoods and or room lighting
- Heat recovery system for fume hood exhaust

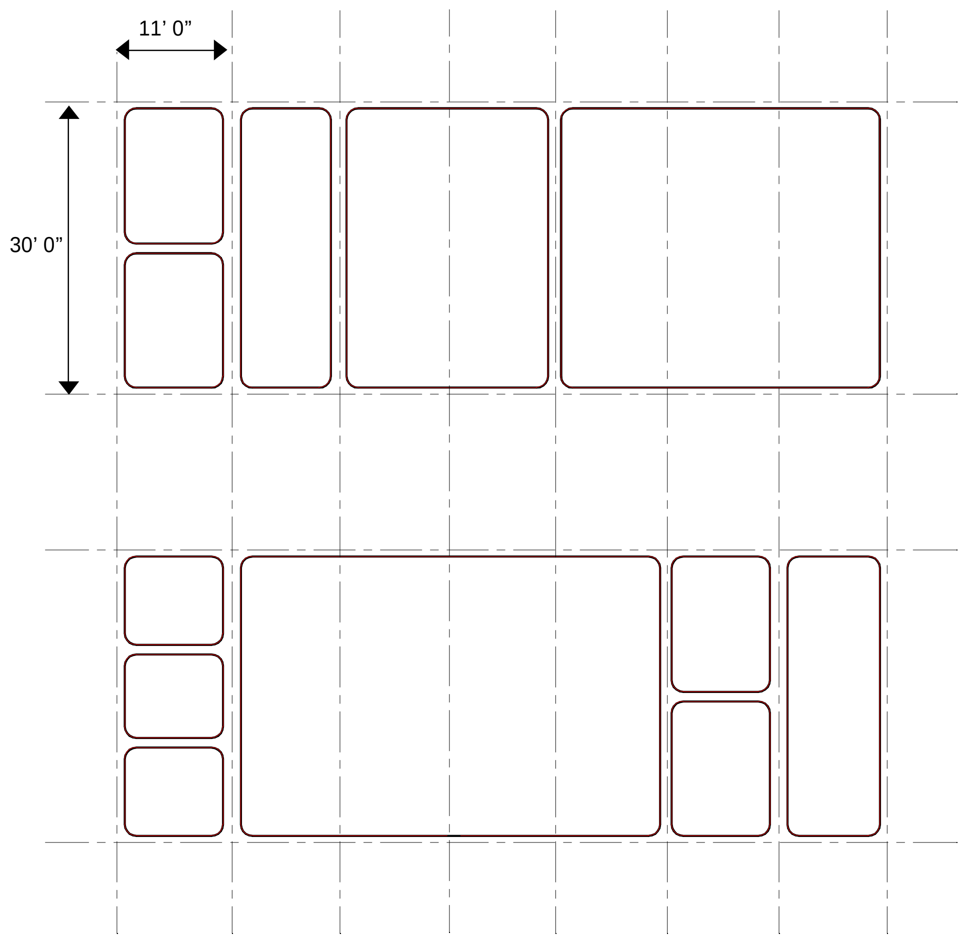
Another potential measure that can contribute to a reasonable sustainability strategy for the laboratory design is the minimization of base cabinetry and simplification of base cabinetry configurations. During the design phase it will be important to work with the faculty and university to find the appropriate casework system that can both satisfy the laboratory storage requirements with the minimum use of materials and energy investment in their processing.

3.6.4 Modular Planning & Flexibility

Laboratories in the Materials Science and Engineering building will be organized around modular planning principles characterized by standardized units or dimensions for flexibility and a variety of uses. Modular planning is used as an organizational tool to allocate space within a building. The module establishes a grid by which walls and partitions are located. As modifications are required because of changes in laboratory use, instrumentation, or departmental organization, partitions can be relocated, doors moved, and laboratories expanded into larger laboratory units or contracted into smaller laboratory units without requiring reconstruction of structural or mechanical building elements.

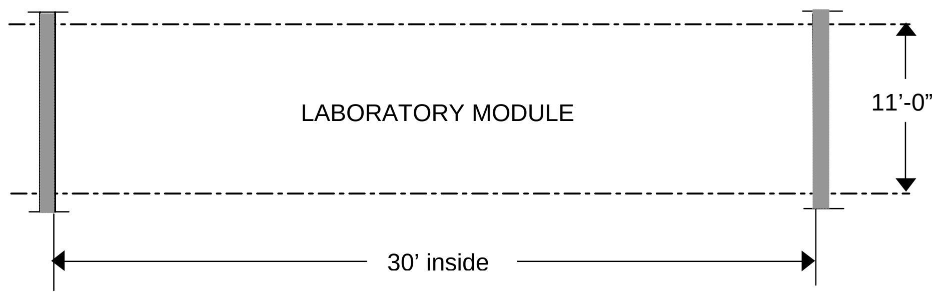
The planning modules may be combined to produce large, open laboratories or subdivided to produce small instrument or special-use laboratories.

The above description of the planning module also includes the organized and systematic delivery of laboratory piped services, HVAC, fume hood exhaust ducts, power and signal cables. If these services are delivered to each laboratory unit in a consistent manner, then changes in laboratory use requiring addition or deletion of services will be easy to accomplish because of the constant nature of the infrastructure.



The proposed laboratory planning module for the Materials Science and Engineering Building was derived by analyzing the laboratory bench, equipment, and circulation space required for the Materials Science and Engineering Building functions. The module is based on the bench space (width and length) required for technical work stations, instruments, and procedures. The space required between benches is designed to allow people to work back-to-back at adjacent benches, to allow for accessibility for disabled and still allow for movement of people and laboratory carts in the aisle.

A planning module approximately 11'-0" wide by 30'-0" deep is recommended for the laboratory spaces. This module will provide adequate bench space plus space for floor standing equipment and fume hoods, and can be divided for smaller support spaces such as equipment and instrument rooms. The recommended module size will be tested against the column spacing and exterior wall locations of the proposed relocation site during the design phases, and may be adjusted accordingly.



Island benches which are 5'-6" deep and wall benches 2'-9"deep are recommended to accommodate the anticipated instruments to be used in the Materials Science and Engineering Building.

A 5'-0" minimum aisle between benches will minimize circulation conflicts and reduce potential safety hazards. It is critical in all laboratory spaces that carts be able to maneuver without conflict in all aisles.

The proposed module width will accommodate the above requirements and will provide sufficient space in laboratories when movable computer stations or equipment racks are used near laboratory benches.

3.6.5 Accessibility

Providing accessibility for persons with disabilities requires special design considerations. The facility must conform to applicable local, state and federal regulations. Earlier considerations should be given to the following accessibility aspects:

All parts of the building should be accessible by persons with disabilities.

Accessible work stations and fume hoods should be provided in the laboratories based on code requirements.

Location of accessible work stations as close as possible to eyewash and safety showers.

An 18" clearance on the pull side and 12” clearance on the push side of doors opposite the hinged side is required.

Some general criteria and guidelines for accessible work stations in laboratories are as follows:

Work surfaces 30" - 34" above floor with wheelchair clearance below. Adjustable work surfaces can provide a range of possible height adjustments.

Laboratory service controls, equipment, and equipment controls within easy reach for persons with limited mobility. Controls should have single-action levers or blade handles for easy operation.

Aisle widths and clearances adequate for maneuvers of wheelchair bound individuals. Aisles 5'-0" wide are recommended with turnaround areas.

3.6.6 Noise Control

Noise control requires specific attention to design and construction details. The following features should be addressed in the design of the mechanical and electrical systems:

Fan noise transmitted to spaces through the duct system or through the building structure. This noise is characterized by a low-frequency rumble and often includes annoying pure tones.

Noise generated by the excitation of duct wall resonance produced by fan noise, by pressure fluctuations caused by fan instability, and by high turbulence caused by discontinuance in the duct system.

Noise generated by air flowing past dampers, turning vanes, terminal device louvers, and comprising mid-to-high frequency energy.

Water circulation system noise caused by high velocities or abrupt pressure changes and is generally transmitted through structural connections.

Noise and vibration caused by out-of-balance forces generated by the operation of fans, pumps, compressors, etc.

Magnetostrictive hum associated with the operation of fluorescent lighting ballasts, transformers, or electric motors.

Elevator equipment noise from motor generators, hoist gear, and counterweight movement; or from hydraulic pump systems.

Other design precautions include:

Conduits should not directly link noise-sensitive spaces, nor should they mechanically bridge vibrationally-isolated building elements using a rigid connection.

Flexible conduit must be used for connections to isolated floor slabs, walls, and vibrationally isolated mechanical/electrical devices.

Duct silencers will be considered when duct distance is not sufficient to provide adequate acoustical separation.

3.6.7 Vibration / Structural Considerations

The nature of research activity being conducted in Materials Science and Engineering Building requires structural dynamics consideration.

Footfall-induced vibrations on above-grade floors should be reduced by:
- Confining heavily traveled areas to regions near column lines,
- Placing sensitive equipment near columns,
- Placing the equipment away from heavily traveled areas,
- Minimizing the length of spans.

Increasing the stiffness of the floor slab alleviates vibration. Providing a combination of mass and/or depth for above grade slabs increases the stiffness. Cast-in-place concrete has natural characteristics and mass advantages for vibration reduction; a concrete frame structural system is anticipated in this building.

For vibration considerations laboratory areas should be designed for 125 psf live load.

Air handling equipment and ductwork shall be designed to minimize vibration. Supply and exhaust air fans, compressors, pumps, and other noise and vibration producing equipment should be located in mechanical rooms with protective wall construction. Equipment should be isolated from supporting structure with resilient mounts. Vibration isolators should be selected based on floor stiffness, span extension, equipment power and operating speed.

Instruments that are extremely sensitive to vibration (scanning electron microscope or transmission electron microscope, STM / ATM NMR etc) should ideally be located on slab-on-grade construction to minimize transient structure-borne vibration. Provisions of an isolated slab should be analyzed.

Pneumatic and piezoelectric isolations should be used, as required, on specified highly sensitive equipment.

Vibration criteria for areas intended to accommodate sensitive equipment are based on rms Velocity Level as measured in one-third octave bands of frequency over the range of 8-100 Hz. Generic Vibration Criterion (VC) curves have been developed for different types of equipment. The results are shown in Table 2.

Criterion curves VC-A through VC-E are applicable to research facilities. International Standards Organization (ISO) criteria for human exposure to vibration are also shown.

It is recommended that the structural floor system be designed to meet the VC-A criterion on 3th and 2nd floors, VC-B on 2nd, and the VC-C on grade level with VC-D criterion in the Lithography section of the clean room. The design should follow the AISC Guidelines of Design for Sensitive Equipment.

Seismic stabilization of the structure should be addressed. Natural frequency of floor and building structure should be determined in function of the Seismic Zone of construction site. A minimum building natural frequency of 12Hz is recommended for optimum operation of vibration isolating equipment unless seismic or other criteria may impose a lower frequency.

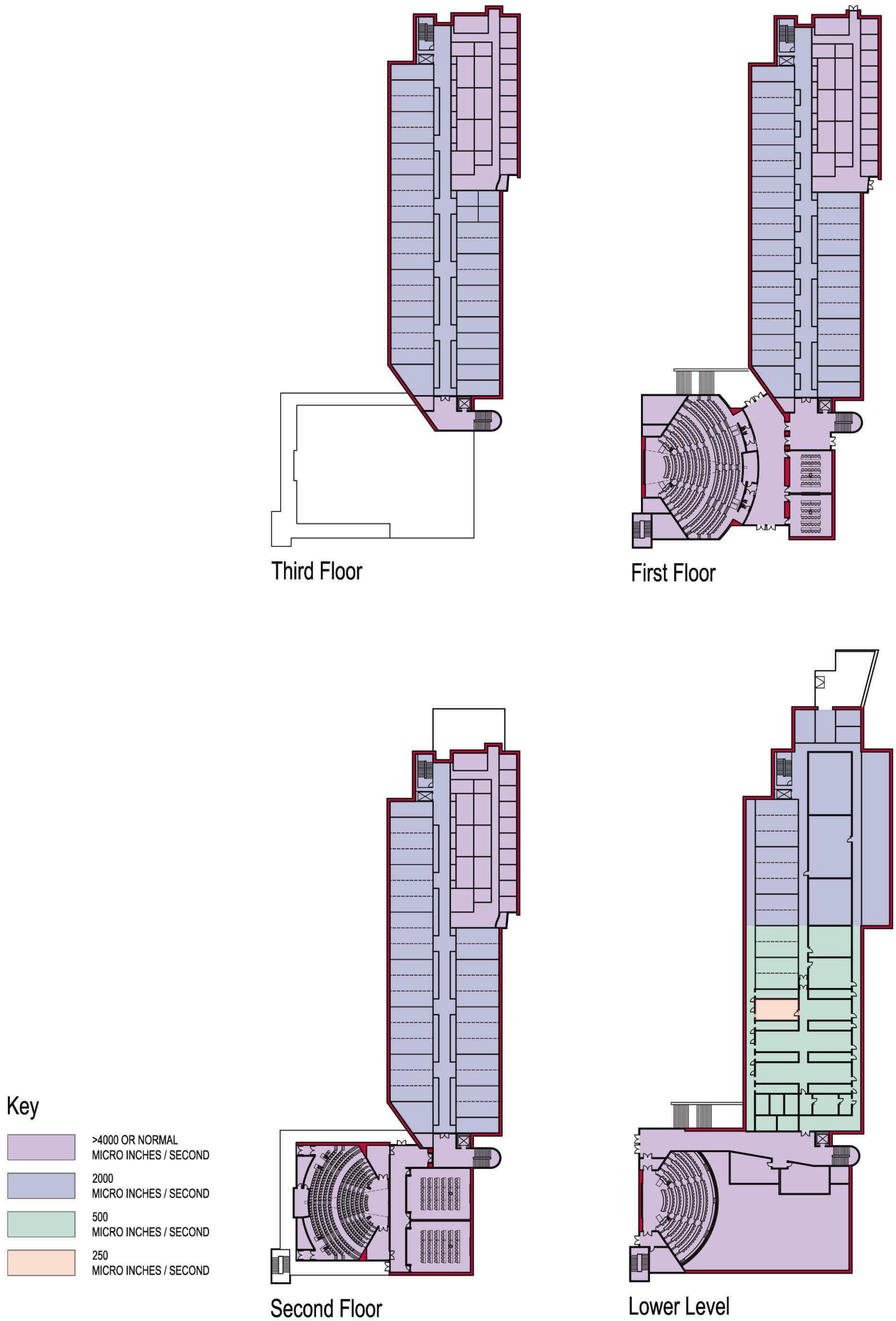
TABLE 2

DESIGN CRITERIA FOR SENSITIVE INSTRUMENTATION AND EQUIPMENT NOT OTHERWISE VIBRATION-ISOLATED

Detail Size column expresses the minimum width of fabrication details or size of research particles that could be handled at a specific criterion value.

Criterion Curve	V_{rms} Velocity Level		Detail Size (μm)	Description of Use
	(μin/s)	(dB) Ref:1μin/s		
Workshop (ISO)	32,000	90	N/A	Distinctly felt vibration. Appropriate to workshops and non-sensitive areas.
Office (ISO)	16,000	84	N/A	Felt vibration. Appropriate to offices and non-sensitive areas.
Residential Day (ISO)	8,000	78	75	Barely felt vibration. Sleep areas in most instances. Probably adequate for computer equipment, probe test equipment and low-power microscopes (to 20X).
Op.Theatre (ISO)	4,000	72	25	Vibration not felt. Suitable for sensitive sleeping areas. Suitable in most instances for microscopes to l00X and for other equipment of low sensitivity.
VC-A	2,000	66	8	Adequate in most instances for optical microscopes to 400X, microbalances, optical balances, proximity and projection aligners, etc.
VC-B	1,000	60	3	Optical microscopes to I000X, inspection and lithography equipment (including steppers) to 3 micron-meter line widths.
VC-C	500	54	1	A good standard for most inspection equipment and lithography to 1 micron micron-meter detail size.
VC-D	250	48	0.3	Suitable in most instances for the most demanding equipment including electron microscopes (TEMs, SEMs, AFMs) and E-Beam systems, operation to the limits of their capacity.
VC-E	125	42	0.1	A difficult criterion to achieve in most instances. Assumed to be adequate for the most demanding of sensitive systems including long path, laser-based, small target systems and other systems.

Vibration Criteria by Area



Planning

4.1 Site Options

The diagram below identifies the six sites which were designated for study and consideration in their capacity to adequately accommodate the program requirements for the Materials Science and Engineering Building as well as conformance to general campus planning guidelines. Complete documentation of the investigation can be found in Appendix IV - Presentation.

Site A: Playing fields - Appropriate location consistent with the LRDP and with the capacity for accommodating the program requirements, particularly for the General Assignment Classrooms, with potential for future expansion

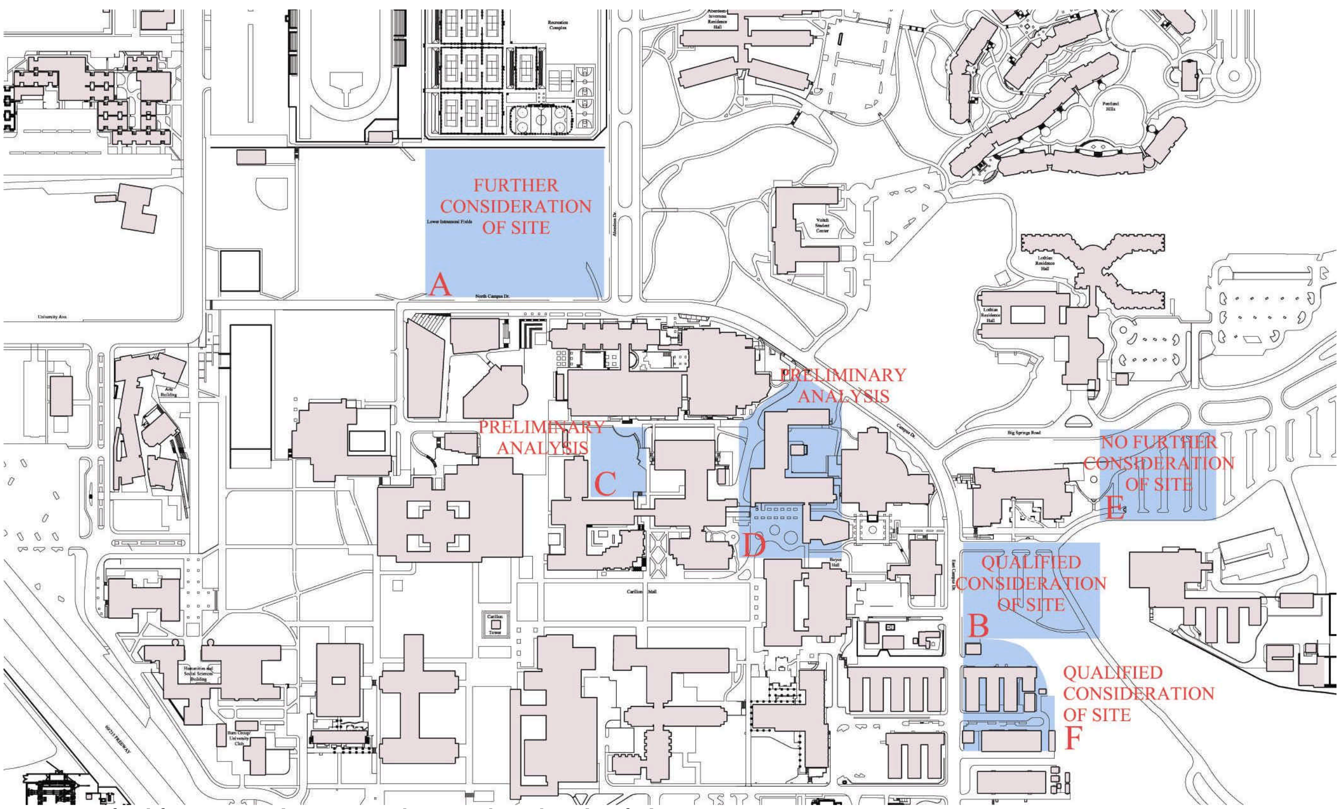
Site B: Physical Sciences Precinct - Appropriate location for Research component; too remote for General Assignment Classrooms. Tight site constraints, especially flood plain.

Site C: Pierce infill – small site reduces floor area capacity, no future expansion capability

Site D: Physics infill – Large area, but requires partial demolition of existing buildings

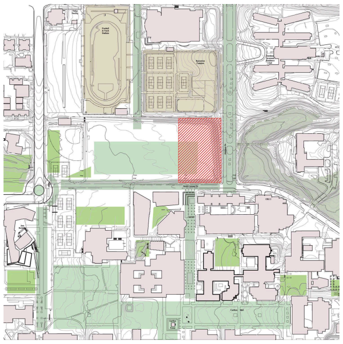
Site E: Physical Sciences Precinct – Parking Lot; too remote for general classroom component

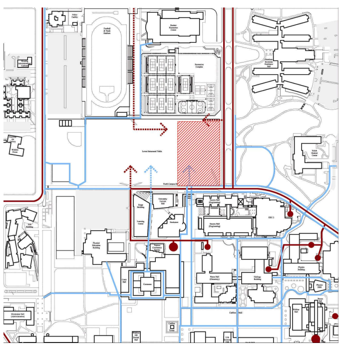
Site F: Greenhouses Precinct – Programmatic adjacencies compromised; too remote for general classroom component.

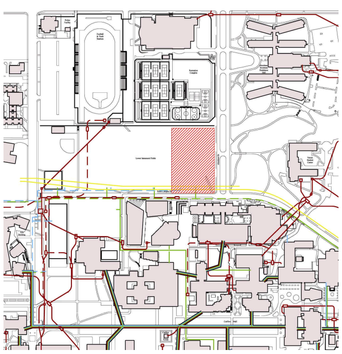


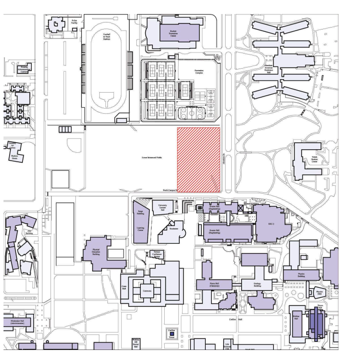
University of California Riverside Campus with Sites A through F identified

4.2 Selected Site / Analysis


Open Space


Vehicular and Pedestrian Circulation

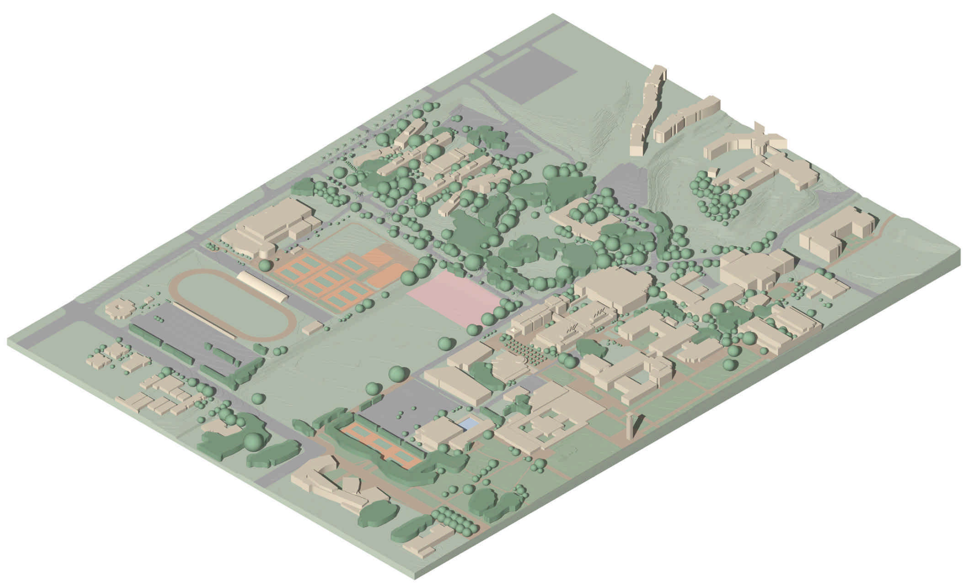

Site Utilities


Building Height

The new Materials Science and Engineering Building will be located at the east portion of the Athletic Fields at the northwest corner of the intersection of Aberdeen Drive and North Campus Drive. During the programming process several alternative configurations of the building organization were considered both as a means to determine the capacity and to qualify the potential of this site.

As the site is used for playing fields it is essentially flat but depressed from the adjacent street and sidewalk grade elevations. Thus in the various configurations of almost any approach, there is the capacity for dual level entry and exiting from the buildings.

The new building will redefine the academic core of the campus as it will be the first major academic building to the north of North Campus Drive and thus establish a new academic core perimeter along Aberdeen Drive and south of the student recreation center outdoor facilities. At the same time the new building will establish an important starting point for the careful development of future campus buildings on the Athletic Fields. The basic precept is to enhance and extend the existing arcadian character of the UCR campus and as such, it is the intent to maximize the open/green space opportunities to create a park-like quality.

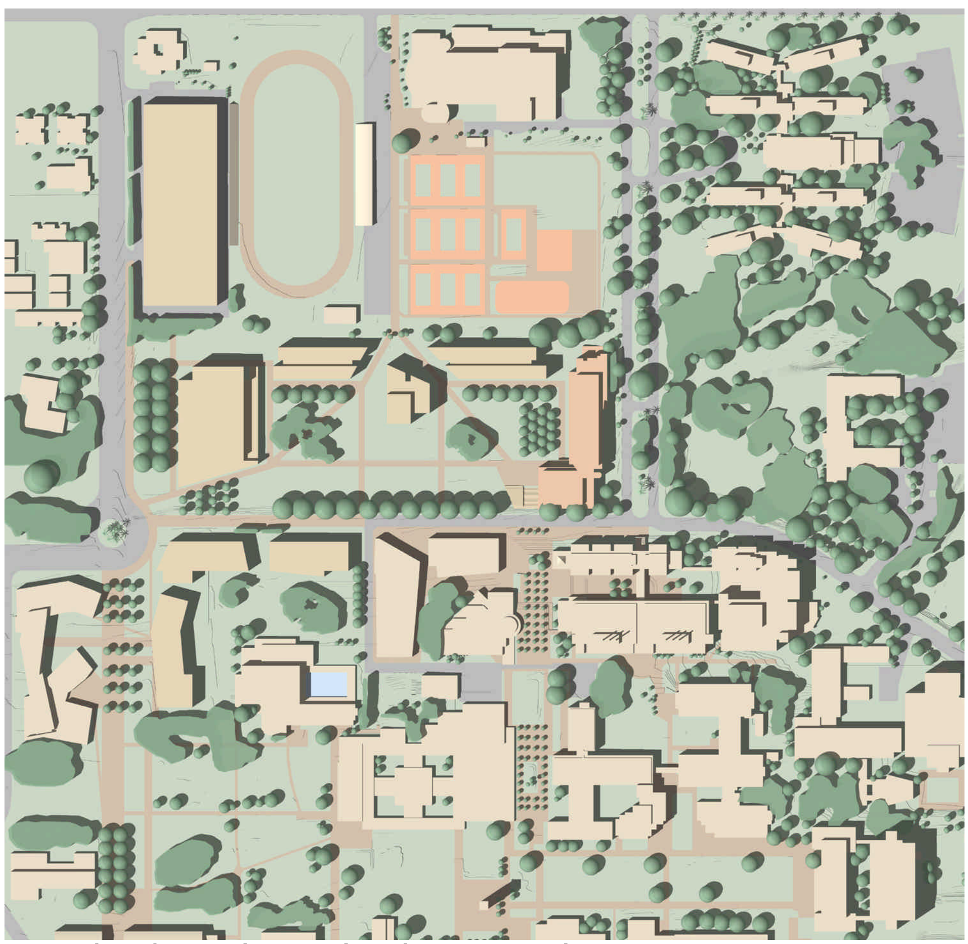

Axonometric view of Campus

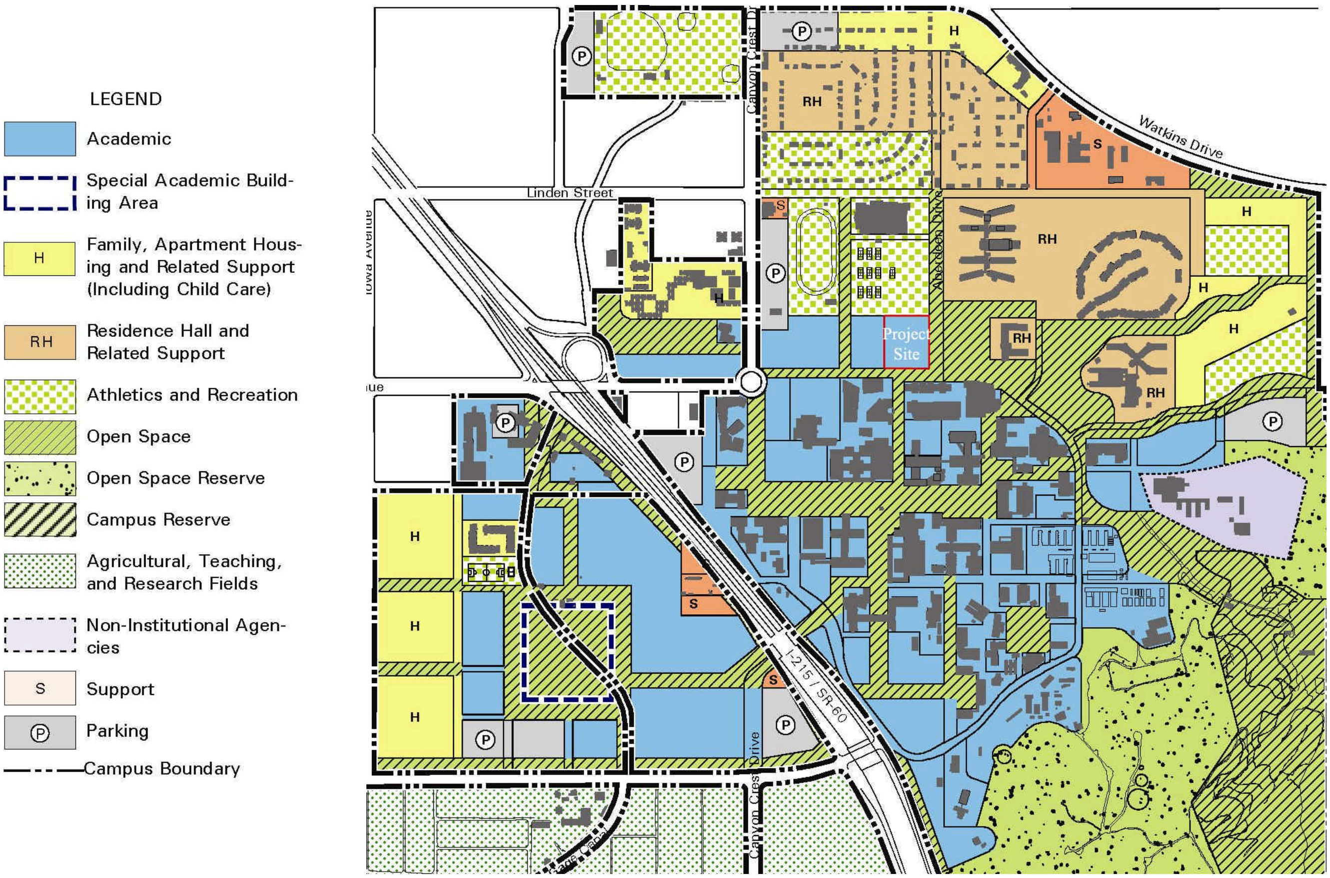
4.3 Campus Planning


View along North Campus Drive towards west

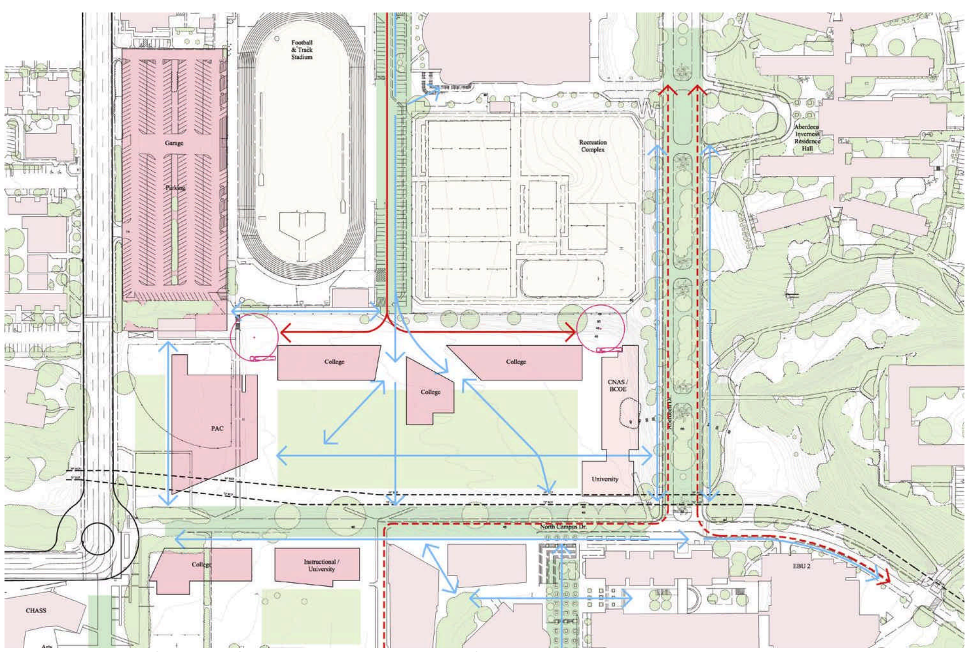

View of site beyond at the intersection of Canyon Crest and University Avenue

The selected site coupled with the laboratory and classroom program for the Materials Science and Engineering project is in compliance with the directives of the 1990 Long Range Development Plan and the LRDP update of 2003, currently in its final draft form. Furthermore, the speculative proposal shown below demonstrates that a sensitive development of future growth can be achieved while creating meaningful campus open space. A more comprehensive investigation of capacity and future development opportunities for this section of campus will be completed in the East Campus Entrance Area Study (2003-04).


Campus Plan with proposed MS&E and speculative capacity study.

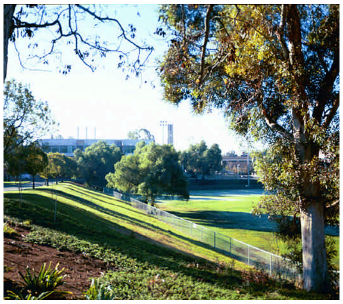


2003 Long Range Development Plan (LRDP)



Capacity Study of Athletic field relative to MS&E and future growth

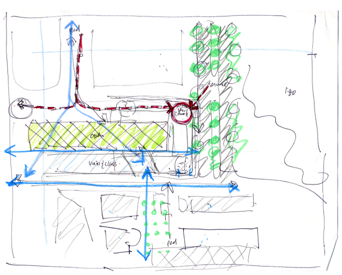
4.4 Site Concept



View of Athletic Fields site towards the south

After extensive analyses and discussions with the DPP Committee a general consensus emerged for the utilization of the site.

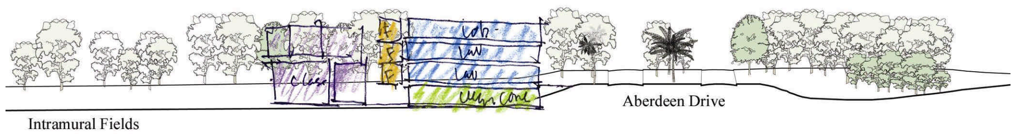
- In general, the building should be located as close to Aberdeen Drive as possible without infringing on the rural boulevard-like character of the road, while minimizing the impact on the Athletic Fields.
- The building should take advantage of the grade differences between the street levels and the depressed playing fields, particularly with the possibility of multi level entry to the building.
- The classrooms should be located to the south near the intersection of Aberdeen Drive and North Campus Drive and thereby in close proximity to other core campus facilities such as the University Lecture Hall, the Student Commons, and the Library.
- The laboratory and classroom components require some degree of separation. However, the two will be connected at a juncture that will act as a common space for the building and will allow for the pedestrian passage through and down to the campus open spaces to the west.
- Service and loading for the facility should be at the north end of the site at the level of the Athletic Fields. Access to this area should be from the west, nestled in to the embankment separating the Student Recreation and outdoor facilities from the Athletic Fields.



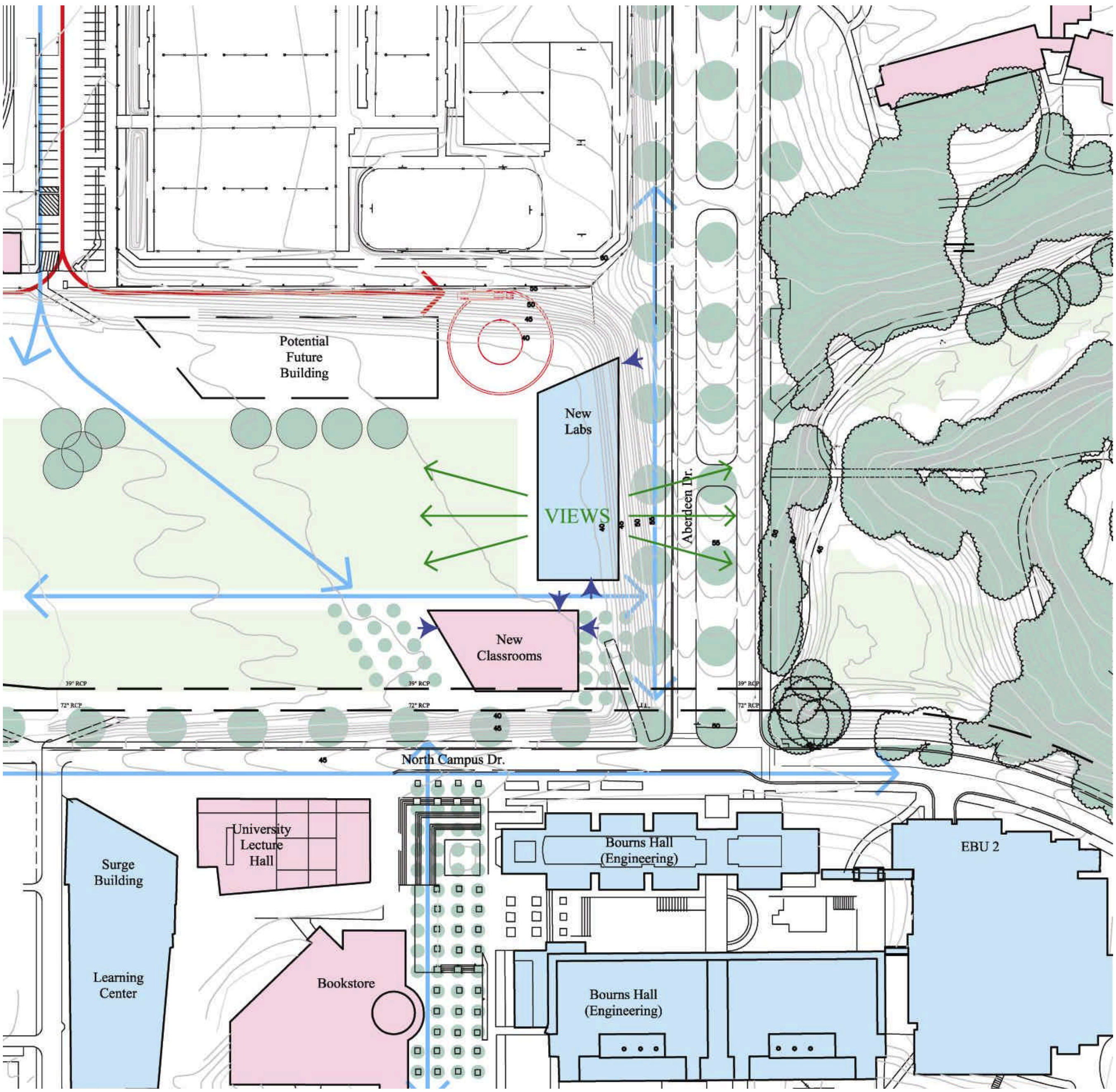
Site Concept Sketch

- The new building with service dock and access should be configured such that future buildings may provide the natural expansion and potential programmatic connection with the MS&E Building while minimizing its impact on campus open space.
- Research laboratories and faculty offices should be placed so that the panoramic views to the east and west are preserved.
- The site design will need to respond to the “University Arroyo” project planned for the south end of the building site.

View of Athletic Fields site towards the east

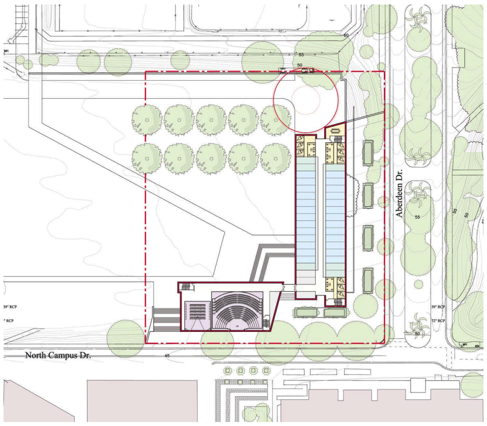


Site Section looking north



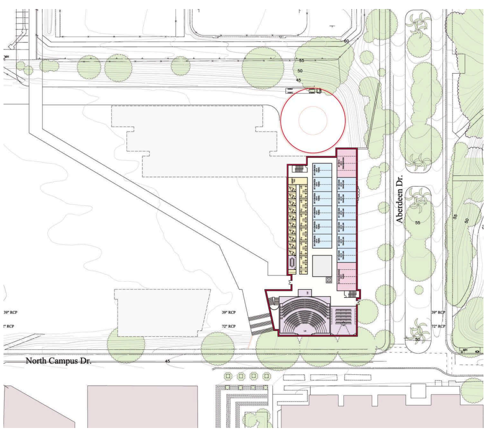
Site Concept Diagram

As part of the testing and development of both site and building concept, three schemes were presented and evaluated. These are shown and discussed below. Complete drawings for each scheme can be found in **Appendix IV – Presentation**.



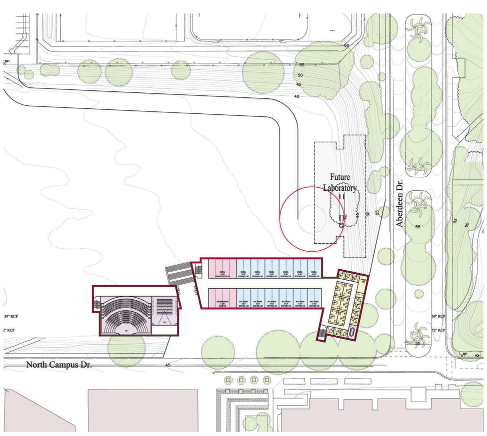
Site Concept - option A

Option A
Similar to the proposed site and building concept except the lab and classroom components have become more distinct to the extent that they are essentially two separate buildings.



Site Concept - option B

Option B
Similar to the proposed site and building concept except that the classroom and laboratory components have fused into a single building.



Site Concept - option C

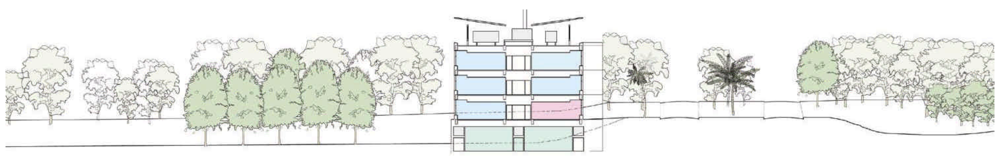
Option C
Basic orientation of this scheme is east-west rather than north-south with the laboratories connecting the classrooms to the west and the faculty office to the east. While framing a small south facing entry plaza as the terminus to the north-south campus walk, this site arrangement creates difficulties for service access and compromises the potential for future growth.

4.5 Landscape Considerations

Existing Landscape Conditions


View south to Athletic Fields

The existing Athletic Fields project site is approximately twenty feet below the grade of the adjacent streets. The arroyo, a significant landscape feature on that part of campus, continues through the site. The north part of the site is bounded by existing recreational facilities. Aberdeen Drive, a unique divided roadway, borders the east side of the site and separates the site from a heavily landscaped area with a mix of Pepper, Ash, and a variety of native trees and shrubs. Aberdeen Drive establishes the semi-rural characteristic of the Campus and recalls the agricultural past of the region. North Campus Drive, on the south boundary of the site, is lined with 60-70 year old Pepper trees. Some of these trees are in decline and replacement of the declining Pepper trees with London plane trees has been instituted elsewhere on the street.



East-West section through laboratories

Introduction to the Proposed Landscape

The landscape for the project should conform to the campus guidelines and specifically to the landscape organization of the campus. The campus is organized by precinct, and within a precinct the landscape takes the form of:

1. Transition Zones such as the one which occurs between the new building and Aberdeen Road.

2. Central Spaces such as courtyards created by buildings or open quadrangles.

3. Reception Areas such as the stairs and related gathering spaces at the termination of the Commons Mall at North Campus Drive.

Project Landscape Assumptions

The project is oriented primarily to Aberdeen Drive to the east and the Pedestrian Mall to the south with the building held back from the corner to accommodate the arroyo and the creation of a zone that allows for a distinctive landscape identity. It is proposed that the new project reflect the rural character of Aberdeen Drive with glimpses of the building visible behind trees. The eastern façade of the building faces an assumed lushly planted edge that serves

View of project towards the east along North Campus Drive

as a transition from Aberdeen Drive. It is possible to incorporate a bike lanes in the landscape buffer on the west edge of Aberdeen Drive between the new building and the road.

The pedestrian mall south of the site is assumed to be extended and reinforced by stairs at North Campus Drive that step down to an open space or reception area and might be lined with pear trees and punctuated by sycamores in a planter that references the planting south of North Campus Drive. The pedestrian mall would then continue north and terminate in a major open space that occupies the center portion of the project.

Conceptual project site plan

The center open space is proposed as a future enclosed quadrangle comparable to other UCR courtyards and quadrangles. This space, which might be characterized as a central park, would be primarily planted in soft landscape. Shade trees, to protect occupants from the south and west sun, would be an essential element of the quadrangle planting and they would be selected from the Campus-wide Core Plant Material list. The paved areas mark circulation paths and provide seating areas. Site furniture would be incorporated into the planning of the area.

Irrigation

The irrigation system shall provide the most effective method for providing complete ground plane coverage and efficient watering for the new planting. Deep water irrigation shall be provided at the trees. The irrigation system shall be compatible with UCR requirements and utilize a automatic central controller.

4.6 Site Utilities

Required services for the Materials Science and Engineering Building will include natural gas, potable water, sanitary and storm-sewers, fire protection, electric power, telephone/data communication, chilled water, steam and steam condensate. To the extent possible, all utilities should come from existing campus supply sources.

Criteria used on the design of the sewer, storm drain and water facilities should correspond to the Uniform Plumbing Code, Riverside County Fire Department Standards, State Marshal Standards, Campus Fire Marshal Standards and any state or federal requirements. Criteria used for design shall correspond to and be coordinated with the UCR Office of Design and Construction Standards.

All existing buildings in the vicinity will remain operational during demolition, removal, relocation and installation of all new site utilities. The construction of utility relocations and tie-ins will be closely coordinated with UCR Capital and Physical Planning and the Office of Design and Construction.

SITE SEWER SYSTEM

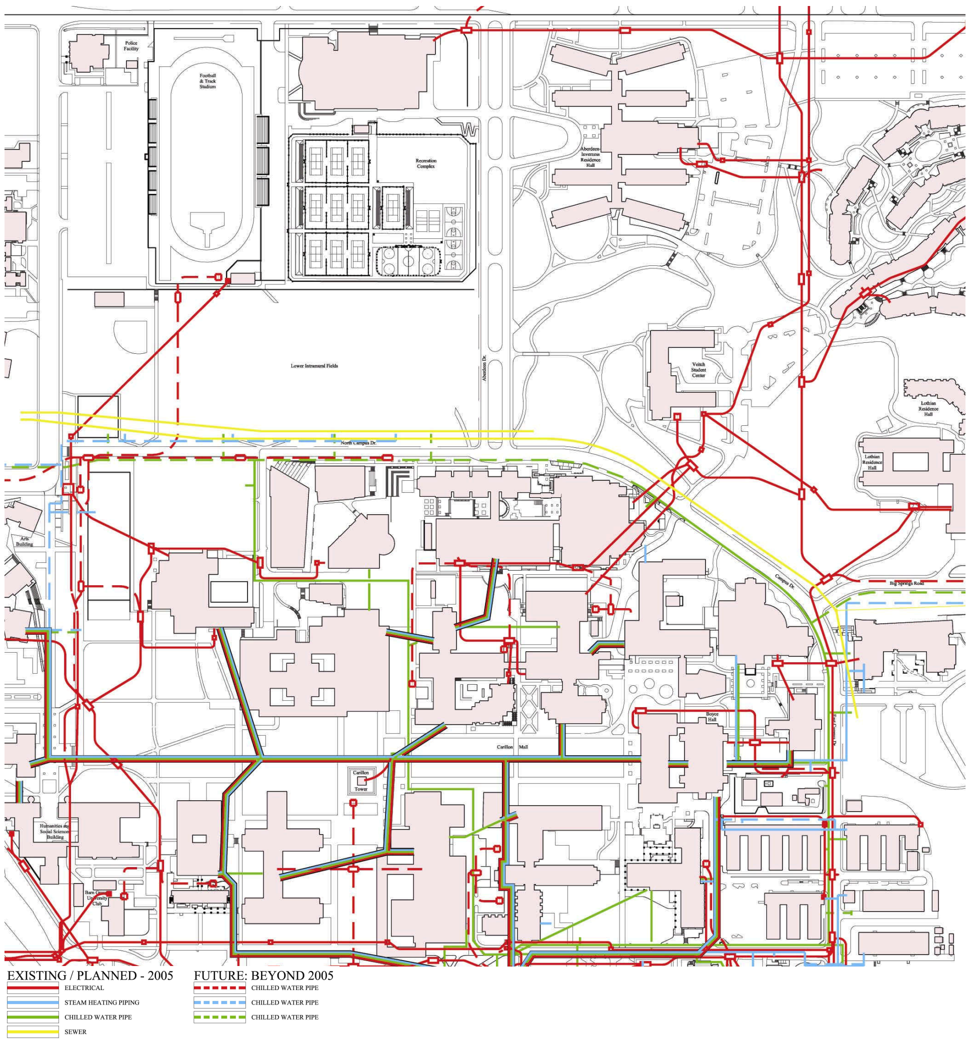
There is an existing 15" sewer line that runs west along North Campus Drive. The sanitary sewer connection for the Materials Science and Engineering building will tie into this existing sewer line near the intersection of North Campus Drive and Aberdeen Drive. Piping material for the new sewer laterals shall be PVC SDR 35, consistent with Campus Design and Construction practice.

SITE STORM WATER

The Materials Science and Engineering site is located within the University Arroyo, which is within the FEMA 100 year flood plain. Major drainage improvements are being accomplished as a part of the University Arroyo project which has among its objectives, the goal of enlarging the University's building land through redefinition of the FEMA 100-year flood plain. There is an existing 72" storm drain line that runs westerly along North Campus Drive. There is also an existing 39" storm drain line that runs westerly (roughly paralleling the 72" line) and under the proposed building area. Runoff from the building and associated site development will be conveyed to this piping system. For proper drainage, this project would include relocation of approximately 600 linear feet of 39" storm drain line. Storm drain piping material shall be PVC SDR 35, consistent with Campus Design and Construction practice.

DOMESTIC AND FIRE WATER

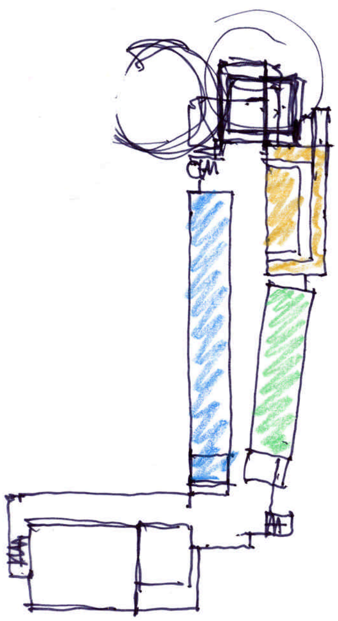
There is an existing combined domestic and firewater loop on campus that includes an 8” water main in North Campus Drive. Water supply for the Materials Science and Engineering building will come from this line. The domestic and fire laterals will require back flow preventors in accordance with the UCR list of approved back flow devices. Water piping material shall be PVC SDR 14, consistent with Campus Design and Construction practice.



Site Utilities Plan

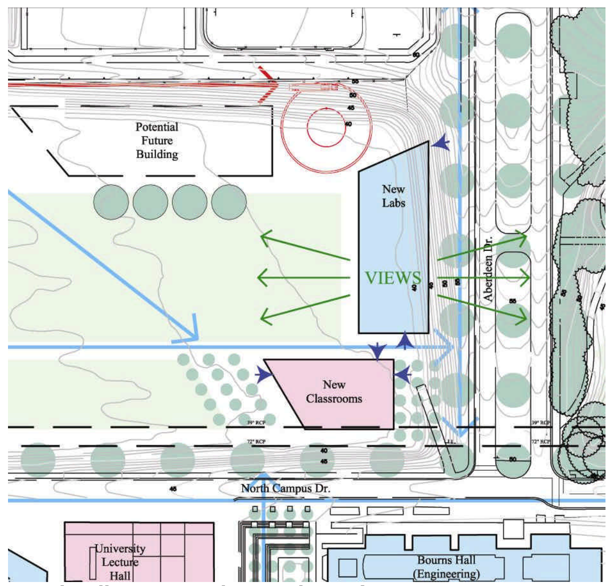
Planning

5.1 Architectural Approach



Conceptual Plan Sketch

The Materials Science and Engineering DPP phase explored and analyzed many complex design issues including campus master planning, site and landscape criteria, program functions and adjacencies, and the vertical stacking distribution of the program elements. These coalesced and resulted in the creation of an L-shaped building massing concept with two distinct components: a laboratory wing which accommodates all research and office functions and an instructional wing housing all the General Assignment Classrooms.



Site Plan illustrating architectural considerations

The following concepts are assumed for the general planning approach should be considered during future planning, design and document phases of the project:

- The laboratory building is four (4) stories plus rooftop mechanical equipment.
- The classroom wing is three (3) stories including a large mechanical level.
- The laboratory lower floor is planned to accommodate the Clean Room Core facility plus support areas and laboratories that are vibration-sensitive. The service dock would be located at the north end of this wing. Vehicular access to the dock would be from the west. The floor-to-floor height at the lower level is 20’-0”.
- The typical laboratory upper floor would house laboratories, lab support, faculty and graduate student offices, and support functions such as instructional labs, library/colloquium space, a small conference room and a work area. The more public component (class and demonstration lab) would be located at grade. With the quantity differences among the research disciplines, it was decided to equally distribute all of the labs and offices on the upper three floors. Certain biases must be recognized however. The

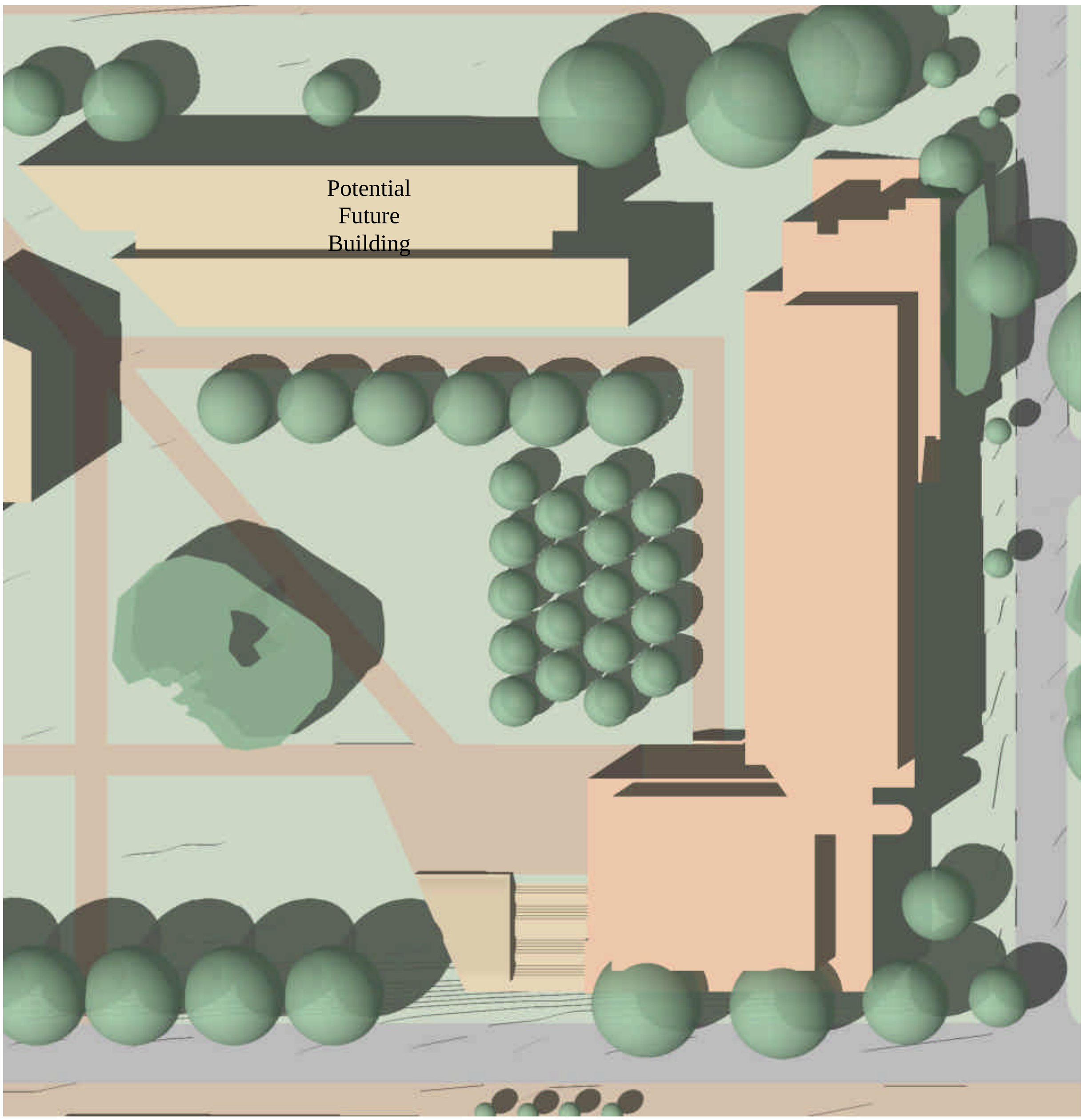
Interactive Engineering Design labs might want to be closer to grade. The Bioengineering labs, with the potential for higher proportion of fume hoods, would be located on the top floor. Materials and Nanotechnology would be on the second and first floors. The typical lab floor is a double-loaded corridor with laboratories running along the entire west side and lab support on the east. The faculty/graduate student offices, organized in a cluster, would be located at the northeast end of this wing. The floor-to-floor height will be 15'-6".

- The classroom wing is conceived as a simple volume with the 300-seat demonstration lab spanning the lower and first floors, with entry from both. A large mechanical space is also on the lower level. The smaller classroom, also accommodating 300-seats, would be located over the larger classroom with entry from the second and third floors. The two 60-seat flat-floored classrooms would be opposite this classroom, while the two 30-seat flat-floored classrooms would be underneath on the first floor.
- Three sets of stairs would serve the building: one at the north end, one at the west, and a large stair serving both classroom and laboratories. A fourth stair may be required to serve the classroom building. This would be dependent on the degree of separation between the two wings. A passenger rated elevator at the north end of the building would serve only the research labs and a smaller ADA compliant elevator would serve the entire building.

View east along North Campus Drive towards MS&E building

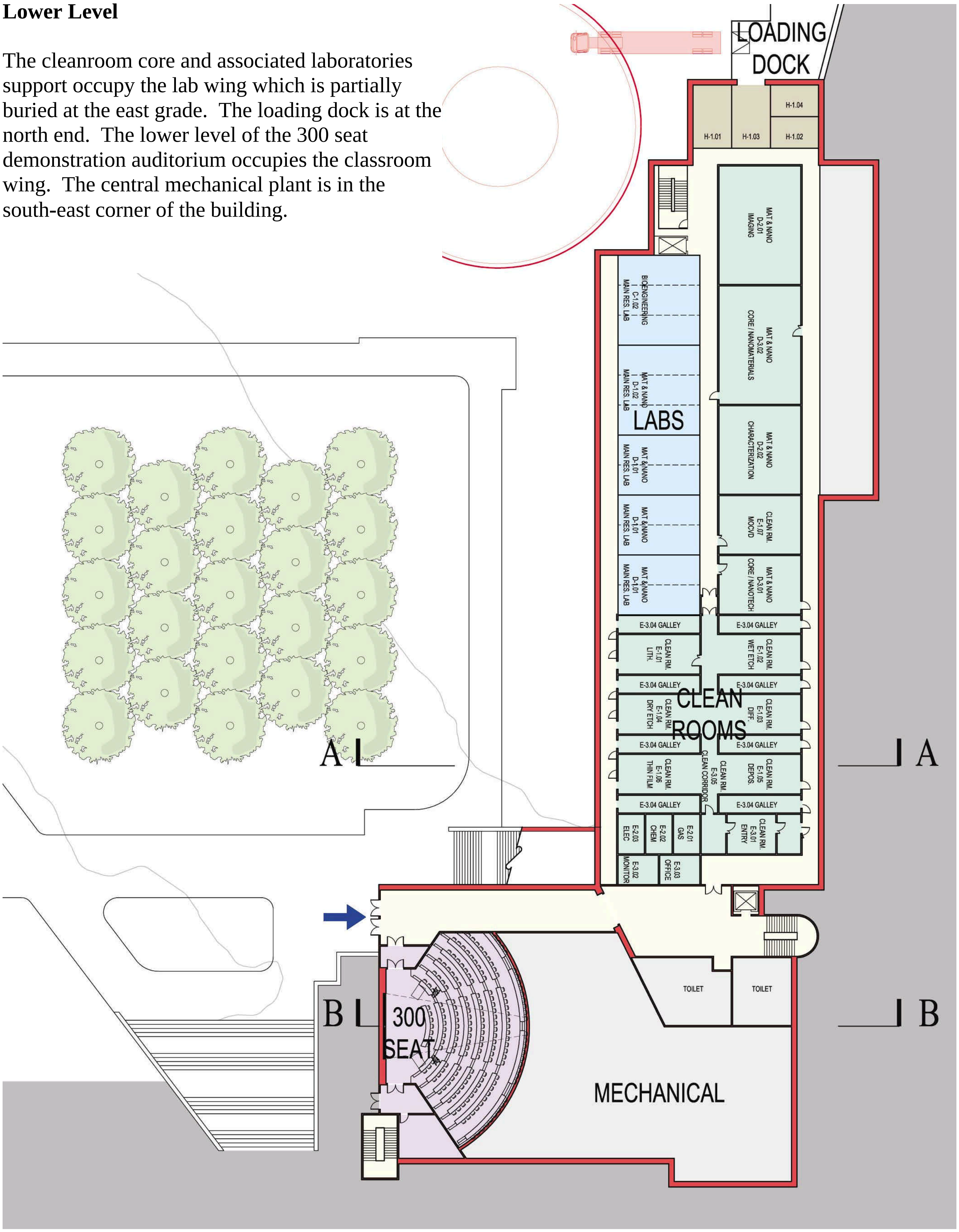
5.2 Building Concept

The building concept design along with the strategy and disposition of the required program elements is shown on the following pages.



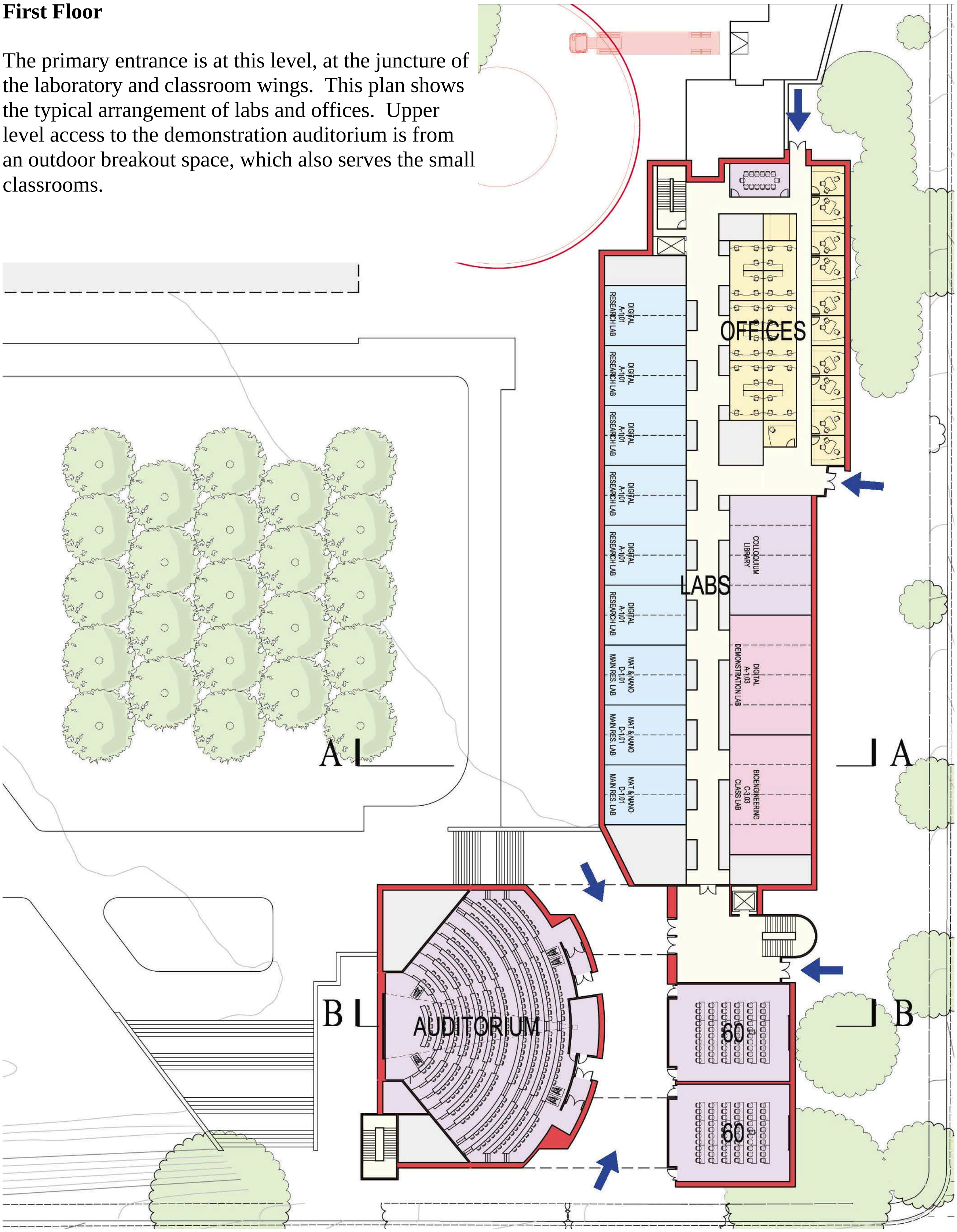
Lower Level

The cleanroom core and associated laboratories support occupy the lab wing which is partially buried at the east grade. The loading dock is at the north end. The lower level of the 300 seat demonstration auditorium occupies the classroom wing. The central mechanical plant is in the south-east corner of the building.



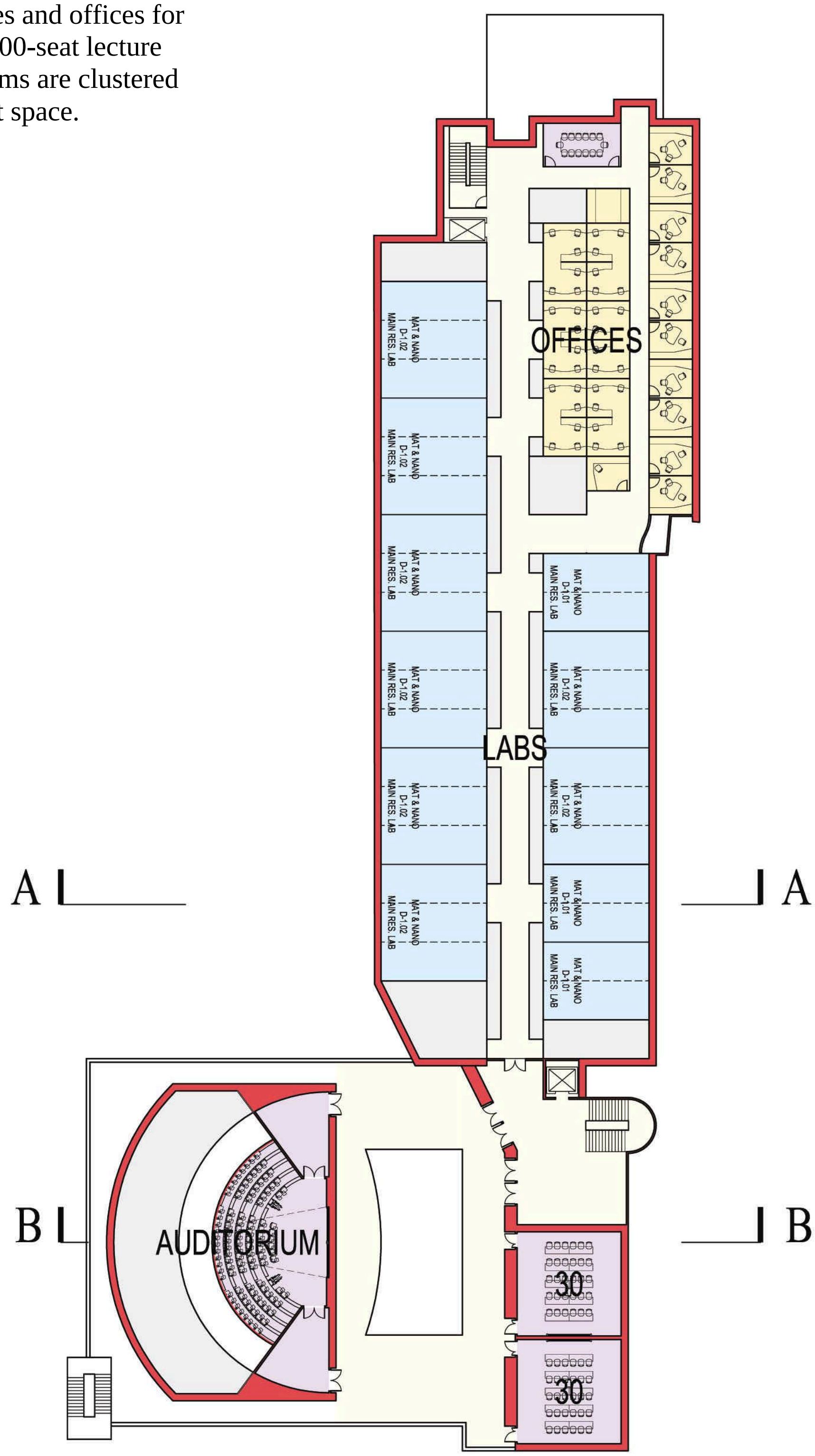
First Floor

The primary entrance is at this level, at the juncture of the laboratory and classroom wings. This plan shows the typical arrangement of labs and offices. Upper level access to the demonstration auditorium is from an outdoor breakout space, which also serves the small classrooms.



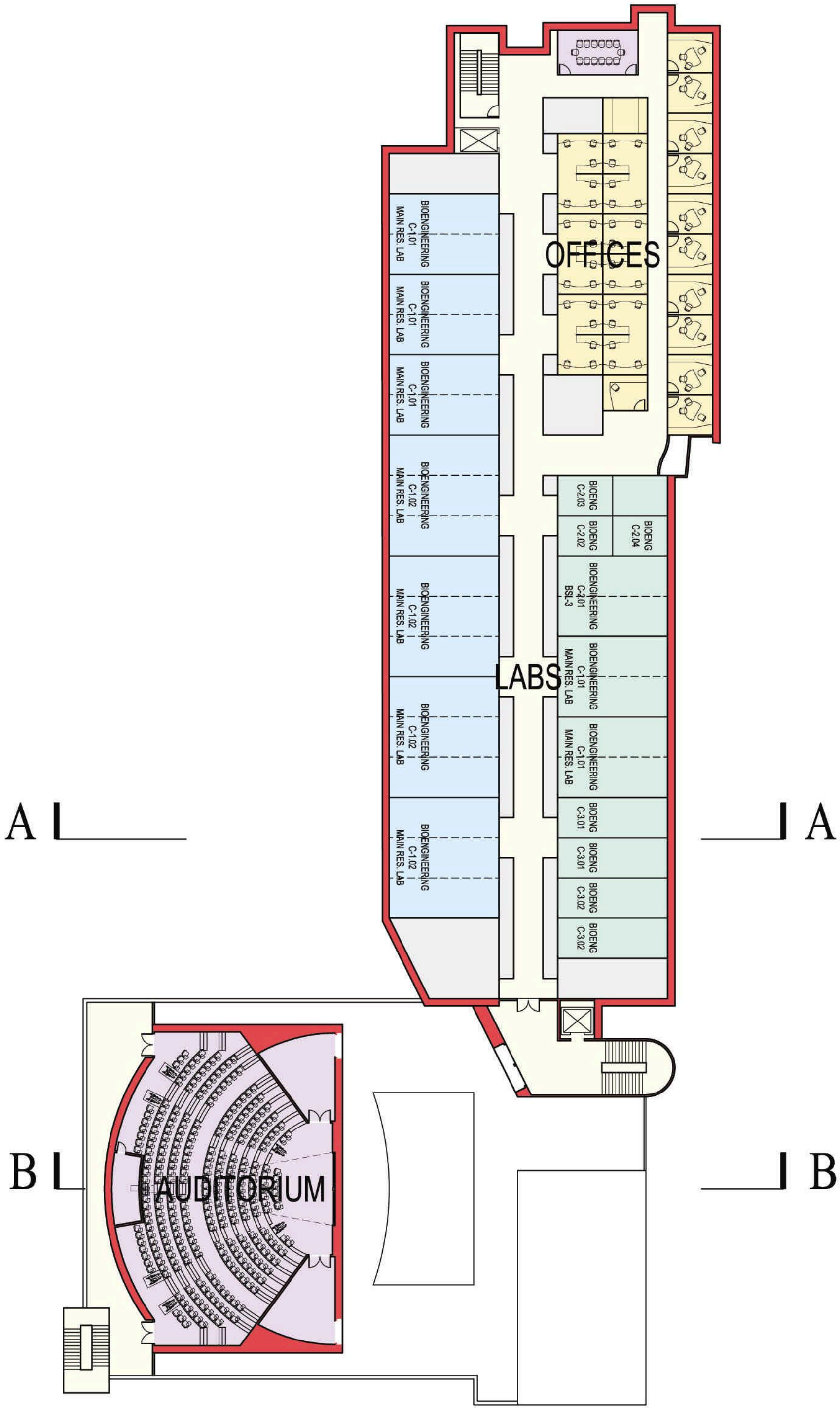
Second Floor

A typical floor plan with laboratories and offices for Materials and Nanosciences. The 300-seat lecture auditorium and the 60-seat classrooms are clustered around a sheltered exterior breakout space.



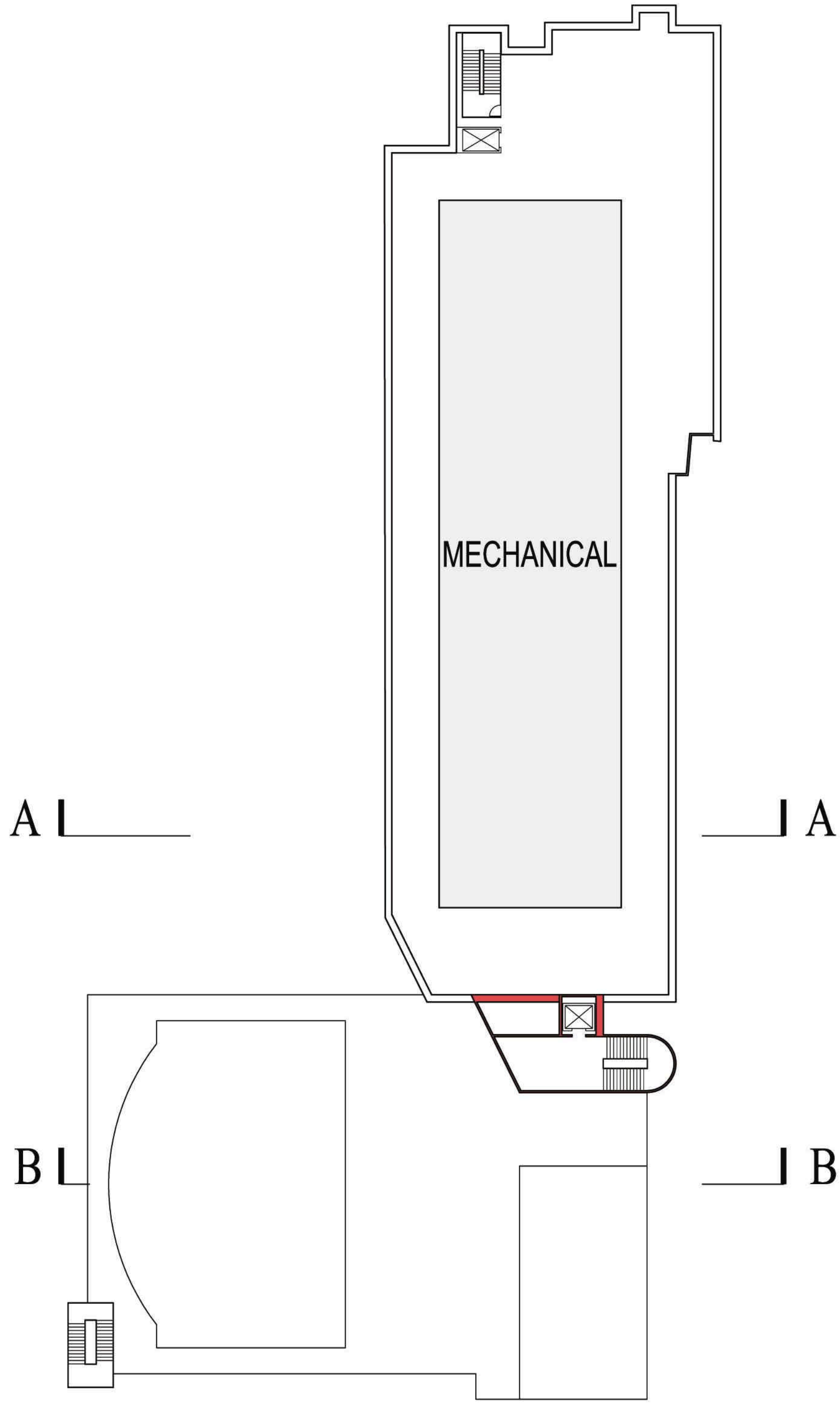
Third Floor

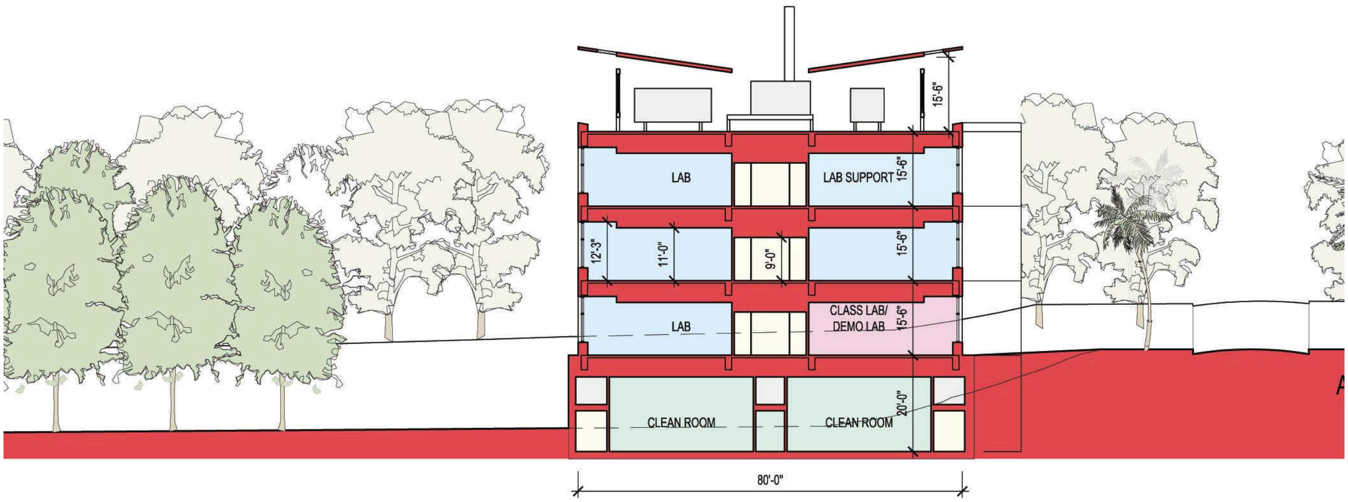
Typical arrangement of a laboratory floor.



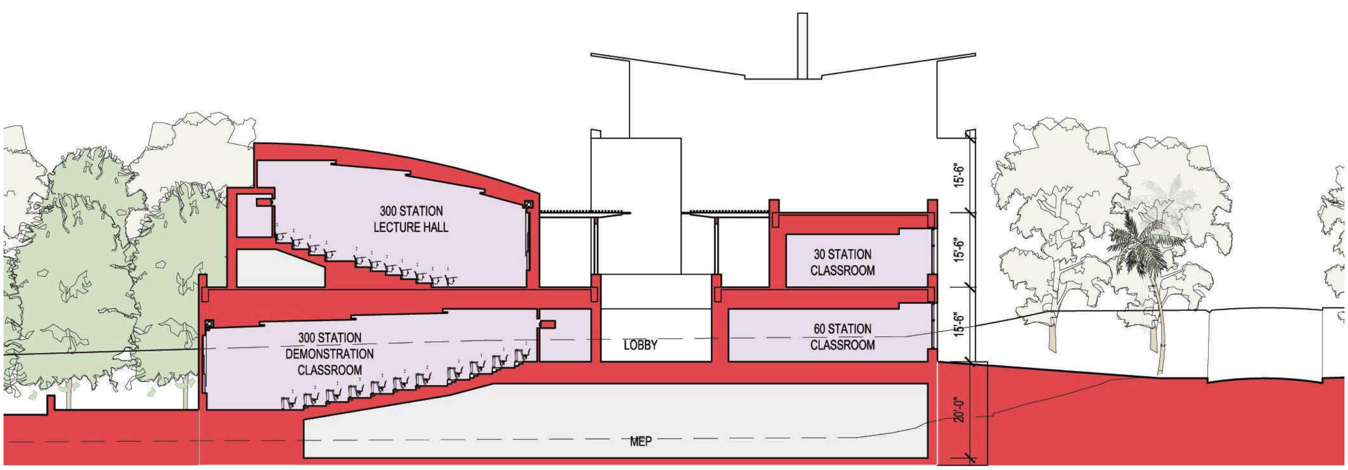
Roof / Penthouse Floor

This level will accommodate most of the airside component of the mechanical plant including the laboratory exhaust fans.





Section A
Through the laboratory wing, showing the disposition of the labs and support about a central corridor on the upper three floors. The clean room core is at the lower level; an air handler and exhaust fans at the rooftop penthouse.



Section B
Through the classroom wing showing the aggregation of the auditoria and classrooms about an open lobby / breakout.

Planning

6.1 HVAC

HEATING, VENTILATING AND AIR CONDITIONING SYSTEMS

Design Philosophy:

The intent of this section is to promote the implementation of cost-effective and energy efficient strategies for systems design and arrangements, equipment selection, distribution, and overall systems integration. These strategies will be undertaken during subsequent design phases.

HVAC system components and distribution layouts shall have the following characteristics:

1. Modular approach
2. Energy responsiveness
3. Flexibility for future changes
4. Durability
5. Ease of maintenance
6. Reliability
7. Redundancy of critical components

Every effort must be made to design, layout and install equipment in locations which will tend to encourage routine preventative maintenance by providing easy access for maintenance personnel.

The HVAC systems shall operate 24 hours per day, 7 days per week, with varying degrees of occupancy in a 24-hour period.

Systems and equipment will be designed in accordance with the applicable code summary sections of this manual.

Sustainability:

During design the team will explore various opportunities to incorporate sustainable design features within the building. While some concepts can prove to be fairly costly, many are not and these will be integrated into the base design. Proposed concepts will be prioritized and, with input from the University, the team will select appropriate elements that fit within the confines of the project's budgetary allocations. Although LEED certification is not mandated for this project, our goal will be to improve California's Title 24 Energy Standards by at least 10 percent, or as defined by Campus/University sustainable design polices currently under development.

Some of the elements specified within the MEP systems that will be incorporated into the base design are as follows:

- Variable volume systems

- Utilization of variable frequency motor controllers
- Carbon dioxide sensors to control outside air ventilation rates
- Economizer provisions for air handling units
- Direct Digital Controls for the HVAC system
- High-efficiency light fixtures, lamps and ballasts
- Occupancy sensors and time clocks
- Occupancy sensors interfaced with the HVAC control system to reduce lab ventilation rates during unoccupied modes
- Premium efficiency motors
- High efficiency transformers
- Low flow plumbing fixtures
- Optimized system efficiencies
- Video-taped system training sessions for the operators

Other concepts that will be explored during design are:

- Reuse of the RO/DI water discharge
- Utilizing steam condensate for pre-heating domestic hot water
- Operable windows in office areas interfaced into the HVAC system
- Enhanced system commissioning
- Lowered systems velocities
- Heat recovery
- Task lighting
- Water free urinals
- Green power sources (photovoltaic)
- Fuel cells
- Day lighting with separate lighting controls

The University also plays a major role in achieving the sustainable goals for this project. Equipment and appliances purchased for use in this building should be efficient and labeled with the Energy Star emblem. Good operations and maintenance of the systems and equipment will also conserve resources.

APPLICABLE CODES

The codes and standards listed below are minimum requirements. In specific instances, the design may exceed the applicable requirements.

1. California Building Standards Administrative Code (Title 24, Part 1), 1998
2. California Building Code (Title 24, Part 2), 1998
3. California Electrical Code (Title 24, Part 3), 1998
4. California Mechanical Code (Title 24, Part 4), 1998
5. California Energy Code (Title 24, Part 6), 1998 edition with 2001 energy regulations.
6. California Fire Code (Title 24, Part 9), 1998

7. California Referenced Standards Code (Title 24, Part 12), 1998

Note: The above code applicability must be reviewed and updated for applicable codes at the time of permitting.

The DPP assumes the clean room component of the project will not be classified as an H-6 occupancy.

REFERENCES AND STANDARDS

1. NFPA 30: Flammable and Combustible Liquids Code, 1996
2. NFPA 37: Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
3. NFPA 45: Fire Protection for Laboratories Using Chemicals, 2000
4. NFPA 90A: Standard for the Installation of Air Conditioning and Ventilation Systems
5. NFPA 90B: Standard for the Installation of Warm Air Heating and Air Conditioning Systems
6. ANSI/AIHA Z9.5: American National Standard for Laboratory Ventilations, 1992
7. NIH 93-8395: Bio-safety in Microbiology and Biomedical Laboratories
8. NIH: Design Policy and Guidelines, Bethesda, MD, February 1996
9. UL: Underwriters Laboratories, Inc.
10. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers Handbooks (Latest Editions)
11. ASHRAE Standard 62-1989: Ventilation for Acceptable Indoor Air Quality
12. SMACNA: Sheet Metal and Air Conditioning Contractors National Association, Inc., Guidelines and Standards (Latest Editions)

The applicable codes, references and standards should be reviewed and updated as the design progresses.

DESIGN CRITERIA/CONDITIONS

Exterior Design Temperature (Based on ASHRAE and UCR Standards):

Summer	110°F / 68°F wb
Winter	34°F db

Interior Design Temperatures:

	Winter	Summer
Public Spaces	71°F ± 3°	75°F ± 2°
Office Spaces	71°F ± 3°	75°F ± 2°
Classroom/Auditorium Spaces	71°F ± 3°	75°F ± 2°

Instructional Labs, Research Labs, and Lab Support	71°F ± 3°	75°F ± 2°
Mechanical/Electrical Spaces	65°F Min.	95°F Max.
Clean Rooms	68°F ± 2°	68°F ± 2°

Final design criteria will be developed during detail design.

Interior Design Humidity:

	Winter	Summer
Public Spaces	Uncontrolled	55% Max. ± 5%
Office Spaces	Uncontrolled	55% Max. ± 5%
Classroom/Auditorium Spaces	Uncontrolled	55% Max. ± 5%
Instructional Labs, Research Labs, and Lab Support	20% ± 5%	55% Max. ± 5%
Mechanical/Electrical Rooms	Uncontrolled	Uncontrolled
Clean Rooms	44% ± 5%	44% ± 5%

Interior Heat Loads:

Area	Equipment Load Watts/SF	Lighting Load Watts/SF	Total
Public Spaces	0.5	1.5	2.0
Offices	4.0	1.5	5.5
Classrooms	1.0	1.5	2.5
Wet Labs	8.0	1.5	9.5
Dry Labs	10.0	1.5	11.5
Clean Rooms	30.0(*)	3.5	33.5

(*)This value represents the estimated average load.

Filtration Levels:

Public Spaces: 30% Pre-filters, 65% after filters
Offices: 30% Pre-filters, 65% after filters
Classrooms: 30% Pre-filters, 65% after filters
Laboratories: 30% Pre-filters, 85% after filters
Clean Rooms: 30% and 65% Pre-filters, 95% final filters and 99.99% HEPA terminal filters

Clean Room Classifications:

For clean room space classification, refer to the Programming Document.

Ventilation Rates and Pressure Relationships

The following ventilation rates are proposed. Data may be subject to change upon review by UCR and finalization of cooling load and make-up air requirements.

<u>Public Spaces/Offices/Classroom/"Dry" Laboratories:</u>

O.A.:	20 cfm/ occupant minimum
Air Circulation:	As required by the cooling load
Pressure:	Positive relative to ambient and adjacent laboratories

<u>"Wet" Laboratories:</u>

O.A.:	100% outside air
Air Circulation:	Min. 12 AC's occupied (verify in Schematic Design) Min. 6 AC's unoccupied
Pressure:	Negative to offices and public spaces

<u>Clean Room Areas:</u>

O.A.:	As required for exhaust and pressurization	
Air Circulation:	Class 100	240 ACH (Air Changes/ Hour)
	Class 1000	150 ACH
	Class 10,000	50 ACH (verify in Schematic Design)
Pressure:	Positive relative to service aisles	

<u>Clean Room Hazardous Material Corridor:</u> Minimum 1 cfm/ sf exhaust

<u>Chemical Storage Rooms:</u> Minimum 2 cfm/ sf exhaust (high/low)

<u>Clean Room General, Acid and Solvent Exhausts:</u> Minimum 4 cfm/ sf

<u>Toilets/Housekeeping Closets/Locker Rooms:</u>

O.A.:	100%
Air Circulation:	10 ACH exhaust
Pressure:	Negative relative to adjacent spaces

Acoustical Criteria:

In general, all HVAC air systems will be designed to maintain the noise criteria recommended by ASHRAE. Equipment selections and duct layouts will be reviewed by the Acoustical Consultant.

Offices/Classrooms:	NC 35
Public Areas:	NC 40
Laboratories:	NC 45 (general) – NC 55 (5'-0" from fume hoods)

Clean Rooms: NC 60

Intake and Exhaust Air Locations:

Outside air intakes will be located in a manner to maximize the distance from exhaust outlets of fume hood/general exhaust ventilating systems, vacuum systems, plumbing vents, emergency generator discharge stacks, or from areas which may collect vehicular exhaust or other noxious fumes. Exhaust discharge stacks shall extend above the roof at a height and location as determined by the Air Quality Assessment Report prepared by an independent consultant.

Smoke and Fire Safety:

Air-handling air distribution systems will meet the requirements of the California Building Code and the UCR Fire Marshal. Where smoke partitions are located, zones for HVAC shall be coordinated with compartmentalization, insofar as practical, to minimize the need to penetrate fire and smoke partitions.

If applicable, atrium smoke exhaust will be provided using dedicated exhaust fans (on emergency power) to exhaust the atrium space with make-up air provided by a combination of openings through the façade at ground level and supply air injection by the building air handling systems.

FLEXIBILITY

Air-handling air distribution systems should be designed to afford flexibility for future redesign, primarily by providing accessibility to the duct systems throughout the facility by applying a modular layout of air distribution devices and by providing symmetry and uniformity to the branch layout.

REDUNDANCY

Redundant and parallel systems for supply, exhaust, heating and cooling will be provided so that environmental conditions can be maintained in the research labs with one unit out of service. Redundant elements will be designed for 75% of full load.

VARIABLE VOLUME DESIGN

To maximize energy efficiency, variable volume strategies will be employed to elements of the air and hydronic distribution systems. Motors will be equipped with variable frequency motor controllers (drives) to modulate the pressure within the systems as necessary to support the loads. This takes advantage of each zone’s operational characteristics.

Variable Air Volume (VAV) design will be applied to both the general air distribution and the lab ventilation systems.

SYSTEMS DESCRIPTION

Steam/Heating/Reheat/Process Systems:

High-pressure 100 psi steam (HPS) is distributed throughout the campus. A new 6" high-pressure steam line will be connected to the existing distribution system. Steam will be reduced to medium and low pressures within the building. The condensate will be collected in the building and pumped back to the central plant.

The new piping from the central plant will be connected to the campus system via direct buried lives within 50'-0" from the new building foundation wall and will include anchors, guides, etc. Multiple-pressure reducing stations will reduce the HP steam to medium and low pressures.

A piping distribution (steam/condensate) system will be provided, complete with all required steam traps and other accessories for a complete system.

Medium-pressure steam will be utilized within the building for process loads to various process equipment and clean steam generator. Low-pressure steam will serve the heating hot water heat exchangers, domestic water heaters and humidifiers in the laboratory units.

Clean Steam:

Clean-steam generator and distribution system will be provided to produce clean steam using RO water and will be connected to the clean room systems.

Clean steam piping will be stainless steel.

Building Heat:

Perimeter heating will be via the hot water reheat coils, relying on the heated supply air to offset the building heat losses. The hot water reheat system will be generated via two (2) steam-to-hot water heat exchangers, each sized for 100% of the load with one standby. Two pumps (one active/one stand-by) with VFD's will distribute water to all reheat coils, AHU preheat coils and other heating elements. A complete hot water supply/return piping system will be provided.

Cooling Systems:

The campus is served by an existing Thermal Energy Storage (TES) system and chilled water is distributed throughout. New chilled water lines will be installed under a separate project to within 50'-0" of the new building. This project will tap these new lines and extend 12" chilled water (supply/return) lines, to/from the mechanical room. The pipes will be direct buried.

Chilled water temperature available from the central plant is 38°F to 42°F. However, 46°F should be utilized for design. The minimum return water delta T should be 20°F, with 60°F being the preferred return water temperature.

The chilled water system serving the building loads will connect to the distribution loop with a thermal bridge to meet UCR standards. The building pumping system will consist of two chilled water pumps. A two-way control valve will be provided at each point of chilled water use. Variable frequency drives will vary the speed of the chilled water pumps to maintain a preset minimum pressure differential in the most remote system point.

Low Temperature Chiller:

A low temperature, air cooled, packaged chiller with associated pumps will be considered for low dew point cooling of the Clean Room make-up air system. Unit will provide 30°F leaving water temperature with 10° temperature rise and 30% propylene glycol solution.

Secondary Chilled Water System (Process Cooling):

A dedicated closed loop (plate and frame) system with associated pumps will be provided to serve process equipment.

Secondary chilled water temperatures will be 60°F supply with an anticipated 15°F temperature rise. The system pressure differential will be designed for 50 psi.

Process cooling water will be distributed through insulated copper piping.

SUPPLY AIR SYSTEMS

The Clean Room make-up air handling unit will be 100% outside air serving Clean Rooms and support spaces. Offices and public spaces, including auditoriums and classrooms, will be served by two (2) supply/return air handling units. Laboratories will be served by one (1) 100% outside air handling unit. All units will be custom built, factory fabricated, double wall type, complete with 6-sided casings, dual supply air fans with VFD's, cooling coils, hot water preheat coils, pre and final filters, fan inlet and discharge sound attenuators, fan isolation and intake air dampers, marine lights and access doors.

The Clean Room make-up air handling unit will be constant volume, with an additional low temperature glycol cooling coil downstream of the chilled water coil for low dew point supply air to the Clean Room recirculating units. The office supply/return air handling units will be variable volume, with dual return fans and integral air side economizer. The laboratory unit will be variable volume, one-pass-through air type.

Outside air will be drawn into the units through intake louvers located on the building façade for interior units. Louvers will be integral for outdoor type units. Air will be supplied at approximately 52°F to supply air terminal boxes (people spaces) and/or linear air valves (laboratories), each with a reheat coil and sound attenuator. Supply air quantities will vary to each space, dependent upon ventilation and cooling requirements, down to a minimum air change level, as described in the Design Criteria.

The supply air handling units and respective duct risers will be sized based on 100% connected load in recognition that the system initially will operate at about 80% of capacity due to VAV system diversity. This will allow for future load expansion. In addition, air distribution systems on the floors will be sized for 100% of connected load, for each floor, to allow the shifting of the air capacity within the floor plate.

Air handling unit fans (2 per unit) will be sized such that each fan can produce 75% of design air flow to allow for a minimum of 75% stand-by capability on a design day with no diversity, effectively providing 100% standby the majority of the time with system diversity taken into account.

Clean Room Recirculation Air Handling Units (RAHU) shall be suitable for ducted ceiling HEPA filter application. Units shall be equipped with either centrifugal or plenum fans, internally lined cabinet panels, discharge sound trap, 2-row sensible cooling coil and variable frequency.

Duct Lining:

Lined ductwork will not be allowed in the air stream of any system.

EXHAUST SYSTEMS

All exhaust shall discharge a safe distance above the roof to prevent recirculation through proper dispersion of the air stream into the atmosphere. Discharge stacks shall be designed to release the exhaust air at a minimum level higher than any human working on the roof and at a sufficiently high velocity to enable the exhaust air to disperse. The final height, location and discharge velocities will be in accordance with the recommendations of the Air Quality Assessment Report.

In addition to all other dedicated exhaust, separate 12"∅ dedicated exhaust risers (two per floor) and space for future fans will be provided to serve possible future dedicated exhaust requirements. These risers will provide a route to the roof for future flexibility.

Toilet rooms will be provided with a separate exhaust system.

Mechanical and electrical rooms will be provided with dedicated ventilation and/or exhaust systems.

Clean Room exhaust systems will include each of the following (with standby fan):

System	Duct Material
Acid & Toxic Exhausts	Teflon Coated 316L Stainless Steel
Solvent Exhaust	Galvanized Steel (G-90)
General Room and Equipment Heat Exhausts (may be integrated with other exhausts)	Galvanized Steel (G-90)
HPM Storage Rooms and Delivery Zone Exhausts	Galvanized duct (G-90)
Vacuum Pumps & Gas Cabinets Exhausts	316L Stainless Steel
Future Dedicated Exhaust Risers	316L Stainless Steel

If required, Point-of-Use (POU) Scrubbers will be provided by the University. Further review of the individual Clean Room Tools' utilities and hook-up requirements will occur in the Schematic Design phase.

EMERGENCY GENERATOR SUPPORT

All auxiliary equipment (fans, dampers, muffler, day tank, controls, alarms, piping, exhaust stack, etc.), to support the emergency generator will be provided.

Emergency generator muffler will be furnished by the Electrical Contractor for installation by the Mechanical Contractor.

The following HVAC equipment shall be connected to the emergency power source:

1. Building heating pumps
2. Condensate return pumps
3. ATC panels
4. Control air compressor
5. All Clean Room exhaust systems
6. Clean Room make-up air system at low flow level (no cooling)
7. Clean Room toxic gas monitoring system
8. Process cooling pumps
9. Smoke control fans (if applicable)

BUILDING AUTOMATION SYSTEM

The Building Automation System shall be a combination pneumatic/electric/direct digital control (DDC) system to be connected and interfaced with the University's front end/building automation and control computer. The DDC system shall be comprised of local area networks that communicate with each other to share information. All networks shall be scanned on a regular basis by the CPU to download information such as alarms, energy usage, temperatures, etc. The ATC system shall accomplish all sensing and control via electronics with pneumatic activation for large valves/dampers and electronic activation for small terminal unit valves/dampers. All VAV/VCV/CV and exhaust control air devices shall have individual DDC controllers, fully networked. All air handling units, chilled water and hot water loops, heat exchangers, pumps, fans and other central infrastructure systems shall be controlled via DDC controllers.

VIBRATION ISOLATION AND SEISMIC RESTRAINTS

Equipment, supports and anchorage shall be designed in accordance with the California Building Code for Seismic Zone 4. The following provisions shall be made:

1. Vibration isolation elements for equipment
2. Equipment isolation bases
3. Piping flexible connectors
4. Seismic restrains for isolated equipment
5. Seismic restrains for non-isolated equipment and piping

Preliminary Design Equipment Selections:

Air Handling Units (Custom Made and Package)						
Supply Unit #	**Service**	**CFM**	**OA (%)**	**HP**	**Emergency Power**	**Remarks**
AHU-1	Lab Unit 1	72,500	100%	2 Fans at 75	No	VFD
AHU-2	Lab Unit 2	72,500	100%	2 Fans at 75	No	VFD
AHU-3	Office/ Classrooms	85,000	40%	2 Fans at 100	No	VFD
AHU-4	Clean rooms	30,000	100%	2 Fans at 40	Yes	VFD

Return and Exhaust Fans					
Fan #	**Service**	**CFM**	**HP**	**Emergency Power**	**Remarks**
EX-1a/1b	BSL3 Exhaust	3,500	5	Yes	primary/std-by
EX-2a/2b	Radioisotope Exhaust	2,000	3	Yes	primary std-by
EX-3a/3b	Clean room solvent	15,000	15	Yes	primary/std-by

	exhaust				
EX-4a/4b	Clean room Acid exh.	15,000	15	Yes	primary/std-by
EX-5a/5b	HPM exhaust	4,000	5	Yes	primary/std-by
EX-7	Gas Storage room exh.	400	1.5	Yes	primary/std-by
EX-8	Chem. storage rm exh.	400	1.5	Yes	primary/std-by
EX-9	Wet exhaust	4,000	5	No	
EX-10	Toilet Exhaust	4,000	5	No	
EX-11	Mech. room exhaust	10,000	5	No	
SF-1	Mech. room supply	10,000	5	No	

Heat Exchangers					
Unit #	**Service**	**GPM Output**	**Steam Input, lbs/Hr.**	**Chilled Water Input, GPM**	**Remarks**
HE-1	Heating Hot Water	225	4700	---	
HE-2	Heating Hot Water	225	4700	---	
HE-3	Process Chilled Water	TBD		TBD	

Condensate Pumps					
Unit #	**Service**	**Lbs/Hr**	**HP**	**Emergency Power**	**Remarks**
CP-1	Condensate Return to Plant	15,000	2 at 3	Yes	

Water Pumps					
Unit #	**Service**	**GPM**	**HP**	**Emergency Power**	**Remarks**
HWP-1	Heating Hot Water	210	7.5	Yes	VFD
HWP-2	Heating Hot Water	210	7.5	Yes	VFD
CHP-1	Chilled Water CH-1	1,450	40	Yes	VFD
CHP-2	Chilled Water CH-1	1,450	40	Yes	VFD
CHP-3	Process Chilled Water	TBD	TBD	Yes	VFD
CHP-4	Process Chilled Water	TBD	TBD	Yes	VFD

Chillers						
Unit #	**Service**	**Capacity (Tons)**	**Electric (KW)**		**Emergency Power**	**Remarks**
CH-1	Clean room chiller	35	22.5		Yes	air cooled

Steam Pressure Reducing Stations			
Unit #	**Capacity (Lbs/Hr)**	**PSI**	**Remarks**
PRV-1	15,000	100 to 50	1/3-2/3 valve arrangement
PRV-2	10,000	50 to 10	1/3-2/3 valve arrangement

Control Air Compressor			
Unit #	**Type**	**HP**	**Emergency Power**
DAC-1	Duplex	2 at 7.5	Yes

END OF SECTION

6.2 Electrical

ELECTRICAL SYSTEMS

Design Philosophy:

The intent of this section is to promote the implementation of cost effective and energy efficient strategies for systems design and arrangements, equipment selection, distribution, and overall systems integration. These strategies will be undertaken during subsequent design phases.

Electrical system components and distribution layouts shall have the following characteristics:

1. Modular approach
2. Energy responsiveness
3. Flexibility for future changes
4. Durability
5. Ease of maintenance
6. Reliability
7. Redundancy of critical components

Every effort must be made to design, lay out and install equipment in locations which shall tend to encourage routine preventative maintenance by providing easy access for maintenance personnel.

The electrical systems and equipment shall be designed in accordance with the applicable code summary sections of this manual.

Sustainability:

Refer to the HVAC section (6.1) of this report for discussions related to the MEP aspects of sustainable design.

APPLICABLE CODES

The codes and standards listed below are minimum requirements. In specific instances, the design may exceed the applicable requirements.

1. California Building Standards Administrative Code (Title 24, Part 1), 1998
2. California Building Code (Title 24, Part 2), 1998
3. California Electrical Code (Title 24, Part 4) 1998
4. California Energy Code (Title 24, Part 6), 1998 edition with 2001 energy regulations
5. California Fire Code (Title 24, Part 9), 1998
6. California Referenced Standards Code (Title 24, Part 12), 1998

NOTE: The above code applicability must be reviewed and updated for applicable codes at the time of permitting.

The DPP assumes that the clean room component of the project will not be classified as an H-6 occupancy.

REFERENCES AND STANDARDS

1. NFPA 37: Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
2. NFPA 72: National Fire Alarm Code
3. NFPA 101: National Life Safety Code
4. UL: Underwriters Laboratories, Inc.
5. IEEE: Institute of Electrical and Electronics Engineers Color Series Handbooks (Latest Editions)
6. IES: Illuminating Engineers Society Applications Handbook and Reference Manual (Latest Editions)
7. NETA: InterNational Electrical Testing Association, Acceptance Testing Manual
8. NECA: National Electrical Contractors Association Recommendations
9. NEMA: National Electrical Manufacturers Association
10. ICEA: Insulated Cable Engineers Association

The applicable codes, references and standards should be reviewed and updated as the design progresses.

POWER SYSTEMS DESIGN CRITERIA

Utilization Voltages:

Primary: 12,000V, 3-phase, 3 wire

Secondary:
Normal 480Y/ 277V, 3-phase, 4 wire
208Y/ 120V, 3-phase, 4 wire

Standby/ 480Y/ 277V, 3-phase, 4 wire
Emergency 208Y/ 120V, 3-phase, 4 wire

Branch Circuits:
Receptacles: 120V
Fluorescent Lighting: 277V
Incandescent Lighting: 120V
Motors 1/3 HP and smaller: 120V
Motors 1/2 HP and larger: 480V, 3-phase.

A ground wire shall be provided with each circuit. Refer to the grounding section for additional information.

Design Loads:

The following criteria shall be used in sizing individual branch circuits:

Lighting	Actual installed wattage
Receptacles	180 VA per outlet
Surface Wireway	180 VA per 5 lineal feet of wireway
Special Outlets & Fixed Equipment	Actual installed load of equipment served

Overall space design loads are as follows:

Administration/ Office/ Open Workstations		
Lighting	1.3	VA/ square foot
Receptacles	5.0	VA/ square foot
Classrooms		
Lighting	1.6	VA/ square foot
Receptacles	5.0	VA/ square foot
Auditoriums/ Distance Learning Suites		
Lighting	1.6	VA/ square foot
Receptacles	5.0	VA/ square foot
Workrooms		
Lighting	1.0	VA/ square foot
Receptacles	10.0	VA/ square foot
Circulation/ Lounges/ and Restrooms		
Lighting	0.6	VA/ square foot
Receptacles	1.5	VA/ square foot
Storage/ Support Rooms		
Lighting	0.6	VA/ square foot
Receptacles	1.5	VA/ square foot
Dry Labs		
Lighting	1.6	VA/ square foot
Equip/ Receptacles	25-30	VA/ square foot
Wet Labs		
Lighting	1.6	VA/ square foot
Power	30-40	VA/ square foot
Clean Room		
Lighting	1.6	VA/ square foot
Power	50-60	VA/ square foot
Mechanical/ Plumbing/ Elect. Equipment Rooms		
Lighting	1.0	VA/ square foot
Power		Actual Motor Hp

The following demand factors shall be applied to the service entrance equipment:

Lighting, power, water heating, air conditioning and heating, and other loads (CEC 220-34):	First 3VA/ square foot	100% Demand
	Over 3 to 20 VA/ square foot	75% Demand
	Reminder over 20 VA/ Square foot	25% Demand

Equipment Sizing:

The following criteria shall be used in designing the branch circuitry:

Site

1. Pole lights shall be fed from 277/480V panels and shall generally be limited to 3000 VA per (1) 20A, 277V, 1-pole circuit breaker.
2. Minimum wire size shall be #10. Wiring shall be sized to limit the branch circuit voltage drop to less than 3%.

General Lighting

1. 277V lighting shall generally be limited to 3200 VA per 20A, 1-pole circuit.
2. 120V lighting shall generally be limited to 1500 VA per 20A, 1-pole circuit.

Receptacles

1. Typical convenience receptacles shall be arranged for (3) duplex outlets per 20A, 1-pole circuit, 120V.
2. All duplex and special purpose receptacles indicated for specific equipment shall typically be on a separate dedicated circuit.
3. Work stations and small offices shall be designed with one (1) duplex receptacle per wall and (1) double duplex receptacle at the desk.
4. Conference rooms and common areas shall be equipped with at least one (1) duplex per wall. Typically receptacles shall be spaced on 12 foot centers.
5. Corridors shall be designed with a receptacle spacing of approximately 40 feet.
6. Building support (equipment rooms, storage) shall be designed with one (1) duplex receptacle per wall or one (1) per every 150 square feet, whichever is greater.
7. Workrooms and laboratories shall be designed with pre-wired aluminum raceways. Dual channel raceways will be provided on perimeter walls and at overhead service carriers. Island benches will be equipped with single channel power raceways. 120V, 20A duplex receptacles shall be mounted with the raceways, typically at 24 inches on center. The top compartment of the raceway (on dual channel configurations) shall house communications outlets.

<u>Motors</u>

1. Motors 1/8 HP and under shall be served by 120V circuits.
2. Generally, motors above 1/8 HP shall have individual circuit breakers.
3. Motors ½ HP and larger, shall be 3-phase and on individual 480V circuits.
4. Motors shall be energy efficient per NEMA MG-1 table 12-10.
5. Motors supplied by adjustable frequency drives shall comply with NEMA MG-1 part 31, with cast iron frames.

Circuits with separate neutral conductors shall be provided in computer intensive spaces.

The following are the minimum equipment sizes to be specified:

<u>Minimum Bus Sizes:</u>

480Y/277V Normal and Emergency Lighting Panels	100A
480Y/277V Normal and Emergency Equipment Panels	225A
208Y/120V Lab Equipment Panels	225A
208Y/120V General Receptacle Panels	225A
480V Motor Control Centers	600A

Distribution panels supplied from K-rated type transformers shall have 200% rated neutrals.

<u>Feeder Sizes:</u>

Feeders from service entrance to distribution panels to be sized the same as the distribution panel bus size.

Feeders from distribution panels to secondary panels to be sized the same as the secondary panel bus size. Distribution panels and secondary panels shall be sized for a minimum of 25% future capacity and space availability.

DESCRIPTION OF THE POWER SYSTEMS DISTRIBUTION

Incoming Service:

This quadrant of the campus is served by the 12 kV distribution system. Power is distributed on 15 kV, 500 kcmil, EPR, copper cables, through a series of manholes (vaults) and concrete encased ducts.

A forth coming project will bring two 12 kV circuits down North Campus Drive to new manholes within approximately 50 feet of MSE. From these manholes the 12 kV circuits shall be tapped with 600A elbow connectors and extended to the building’s electrical substation. (A sectionalizing switch may be required - this will require further study.)

Two separate electrical circuits shall be brought to the building for redundancy and reliability. The 12 kV service shall be arranged so that if one primary feeder is out of service, the remaining feeder has sufficient capacity to carry the total load.

The building's distribution system shall be configured in a primary/ secondary selective arrangement with one indoor, double-ended unit substation. The dry type transformers and secondary distribution switchgear will be rated at 2000 kVA, 3000 amps, respectively.

Floor Distribution - Normal Power:

Vertical busways, fed from the substation, shall be provided to distribute power to each floor. At each floor, two (2) plug-in circuit breakers shall be provided on the busway; one for the 480/277V lighting panel; one for a 480 to 208/120V step down transformer. The step down transformers shall service 208/120V distribution panels that will in turn, service local receptacle panels, miscellaneous 120 or 208V equipment, laboratory panels, and light fixture dimming panels.

Lab panelboards shall be located within the corridors and equipped with a main breaker.

Panelboards shall have at least 25% spare breaker capacity above initial requirements.

Mechanical Distribution-Normal Power:

Motor control centers shall be provided in mechanical equipment rooms for all pumps, fans, packaged equipment, etc. Major equipment such as centrifugal chillers shall be fed directly from the substation.

POWER DISTRIBUTION EQUIPMENT

Unit Substation:

The substation shall contain high voltage load break air switches equipped with station class surge arrestors, 115 °C, VPI, dry type transformers with fan assisted cooling, and low voltage distribution switchgear. The main primary switch will be key interlocked with its associated secondary main breakers so that the secondary main breaker is open prior to operation of the associated main primary switch.

Low voltage switchgear shall be rated at 277 / 480V and will include main and tie breakers, electronic metering, transient voltage surge suppression, and distribution sections. All circuit breakers shall be 100% duty rated draw-out power circuit breakers with solid-state trip devices and ground fault protection.

The two main breakers shall be interlocked with the tie circuit breaker so that all three breakers cannot be closed at the same time.

Customer solid-state metering will be provided in accordance with the University's standards.

Switchboards:

Switchboards shall be dead front, completely metal enclosed and have self-supporting structures. All bus bars shall be copper with bolted connections at joints and a dedicated ground bus. Switchboards shall be front accessible with panel mounted molded case circuit breakers with solid-state trip units for devices exceeding 250 amps.

Transient voltage surge suppressors (TVSS) shall be provided at the floor 120/208V volt secondary distribution switchboards.

Vertical Busway:

Vertical busways shall be non-ventilated and supported with adjustable vertical hangers at each floor. Busways shall include phase, neutral and ground copper bus bars. On designated floors, busway shall be plug-in type. Maximum capacity of busway shall be 1600A. Busway shall be braced to withstand the available short circuit currents.

Busway plug-in circuit breakers shall be current limiting type with integral ground fault protection.

Distribution Transformers:

Step-down transformers, 480V to 208/120V, 3-phase 4-wire, shall be 115°C dry-type, 2-winding, and self-cooled. All windings shall be copper. Transformers provided for laboratory equipment shall be suitable for non-sinusoidal current loads with "K" factor not less than 4.

Transformer sound levels shall be 3db below NEMA standards.

Distribution and Branch Circuit Panelboards:

Distribution, lighting, receptacle, and laboratory equipment panelboards shall be dead front construction utilizing molded case circuit breakers. Panels shall be fully rated for the available short circuit current. All branch circuit panelboards shall be trimmed with door-in-door type covers.

Motor Control Centers:

Motor control centers shall be 600V Class for operation at 480V, 3-phase, 3-wire. Structures shall be totally enclosed dead front, freestanding assemblies. Bus bars shall be tin plated copper and braced for the available short circuit currents. Back-to-back type motor control centers shall not be acceptable.

All starters shall be draw out type minimum size NEMA 1. Starters NEMA 3 and above shall be solid state soft start type. All starters shall utilize motor circuit protectors. Each starter shall be equipped with ground fault protection, control power transformer, indicating lights, H-O-A switch and auxiliary contacts.

Equipment Manufacturers:

All components of the distribution equipment, i.e., unit substations, switchboards, distribution panels, panelboards, busways, motor control centers, dry type transformers, etc., shall be furnished by one common manufacturer such as Cutler-Hammer, Square D, or General Electric.

Feeders:

15 kV feeders shall suitable for use on an ungrounded system. Feeders shall have 133 percent insulation, be single-conductor, 15 kV rated, solid-dielectric Ethylene Propylene Rubber (EPR) insulated, shielded, jacketed power cable. The construction shall be suitable for use on 3-phase, 15 kV phase-to-phase, 60 Hz solidly grounded systems. The conductor shall be copper and the insulation system shall be composed of a conductor stress control layer, with a dielectric constant thermostat material, a primary insulation layer of ethylene propylene rubber, an insulation shield consisting of black semi-conducting material, a metallic shield consisting of copper tape and an overall outside jacket of black polyvinyl chloride (PVC).

The 15 kV conductors shall be tested in accordance with NETA standards as follows:

- On the reel at the factory (before shipment)
- After installation but before connection to the system
- After final connections

600V feeders shall be single-conductor, 600V rated with XHHW or XHHW-2 insulation, feeders shall be color coded using color type at all connections and in all pull and junction boxes. All feeders shall be installed in conduit.

Branch Circuits:

Branch circuit conductors shall be single-conductors 600V rated with THHN/THWN-2 insulation with continuous color coding.

Branch circuit conductors shall be designed to utilize the advantage of multi-wire distribution; however, no more than 5 conductors (3-phase, 1 neutral and 1 ground) shall be installed in a common conduit.

Wiring Devices:

Wiring devices shall be specification grade, complete with all accessories. All wiring devices shall be the product of a single manufacturer except where specifically stated otherwise.

Toggle switches shall be full size, heavy duty, AC, quite type, rated for 120/277 volts, at 20 amperes.

Ground fault protection shall be provided for outlets within 6’-0” of a sink edge and other wet locations. Electrical outlets shall be individually ground fault interrupted (GFCI) protected (not at the circuit breaker or first outlet on the circuit).

Receptacles connected to the emergency power system shall be red in color.

All duplex and special purpose receptacles indicated for specific equipment shall be on a separate dedicated circuit.

Wall mounted occupancy sensors shall be passive infrared rated 1,000 watts at 277 volts or 800 watts at 120 volts with integral photocell day light sensor and overriding control. Ceiling mounted sensors shall be dual technology infrared/ ultrasonic devices with integral microprocessor. Sensors for loads that exceed the ratings indicated shall utilize relay control of the branch circuit.

Dimmers shall be 120 volts rated for a minimum of 2,000 watts with slider control. Dimmers shall be Lutron #N2000 Series or approved equal.

Raceways:

Raceways for feeders and branch circuits shall be metallic, rigid metal conduit, intermediate metal conduit (IMC) or electrical metallic tubing (EMT) subject to the restrictions of the California Electrical Code, minimum size 3/4". EMT shall not be used in concrete construction or where subjected to mechanical damage.

Exterior duct banks shall be comprised of PVC Schedule 40 conduit encased in concrete. Where duct banks penetrate foundation walls or manholes, rigid galvanized steel (RGS) conduit shall be used.

Raceways shall not be allowed in concrete floor slabs.

EMERGENCY POWER SYSTEMS DESCRIPTION

One standby emergency diesel engine-generator set, preliminarily sized at 1000 kW (standby), shall be provided to supply electrical power in the event of loss of normal power. The capacity of the generator will need to be validated in the next phase.

The following equipment is proposed to be provided with stand-by emergency power in the event of a normal power failure.

Emergency Systems Power (Life Safety Systems):

1. Egress lighting (0.25 VA/ square foot)
2. Exit signs
3. Fire alarm equipment (0.25 VA/ square foot)
4. Control and CFSD dampers
5. Generator fuel oil pumps
6. Clean room acid exhaust fan
7. Clean room solvent exhaust fan
8. Clean room ventilation of toxic storage rooms
9. Clean room toxic gas cabinet
10. Clean room toxic gas monitoring system

Legally Required Stand-by System Power:

1. Mechanical smoke control equipment (not currently anticipated on this project)
2. Fume hood exhaust system
3. Clean room toxic gas scrubbers or abatement equipment (where required)
4. Sewage ejectors
5. Building Automation System (BAS) and accessories
6. Emergency generator room lighting and receptacles

Optional Stand-by System Power (University Selected Systems):

1. One elevator per bank
2. Selected laboratory equipment
3. Two (2) 208V, 30 amp, 1 phase (3 wires+ plus ground) receptacles per wet lab
4. Lab waste systems
5. Environmental rooms
6. Selected clean room tooling
7. Selected hydronic pumps
8. Additional lighting in selected areas
9. Sump pumps
10. Water booster pumps
11. Hot water circulating pumps

12. Security system
13. Telecommunication system

Emergency Power Distribution:

The generator control switchgear circuit breakers and substation shall provide power to the emergency and normal side of each transfer switch, respectively. The load side of each transfer switch will feed emergency distribution switchboards.

Floor Distribution – Emergency System (Life Safety):

Emergency system switchboards shall provide service to emergency system lighting panels on every floor. The lighting panels will also serve a dry type transformer, 480V to 208/120V for incidental 120V life safety power at selected locations.

Mechanical Distribution – Legally Required and Optional Stand-By:

Motor control centers shall be provided in mechanical equipment rooms for all legally required and optional stand-by system loads such as smoke control exhaust fans, sewage ejectors, pumps, etc.

Elevator Distribution:

A switchboard shall be provided to which all elevator equipment shall be wired. The switchboard shall be fed from the load side of an automatic transfer switch. The normal side of the transfer switch shall be fed from substation, sized for all elevators. The emergency side of the transfer switch shall be sized for one elevator per elevator bank.

EMERGENCY POWER EQUIPMENT

Emergency Standby Generator:

The unit shall be capable of picking up their rated capacity in one step and provide a transition time for the emergency systems (life safety loads priority 1) of (10) seconds or less from instant failure of the normal power source to the emergency generator source. Non-life safety loads (priority 2) shall transfer within (15) seconds from failure of the normal power source.

The generator shall be 480/277V, 3-phase, 4-wire, 60 Hz, 12 lead, 0.8 power factor equipped with a permanent magnet generator (PMG) and brushless construction using a full wave 3-phase rotating rectifier assembly. Equipment shall be Caterpillar or Onan/Cummings.

The engine-generator units shall have the following features/accessories:

1. Electronic isochronous governor
2. Unit mounted control panel
3. Remote annunciator panel
4. Auto start control
5. Voltage regulation ±1% from no-load to full load
6. Waveform harmonic distortion less than 5% total RMS
7. TIF factor less than 50
8. Critical grade silencer
9. Heavy-duty batteries and charger
10. Day tank
11. Vibration isolation

The generator will be located within the building. A day tank and underground fuel storage system will be provided for a minimum 24-hour run time.

Automatic Transfer Switches:

Each automatic transfer switch shall be 4-pole and provided with a bypass isolation switch. The bypass isolation switch will provide a safe and convenient means of manually bypassing and isolating the automatic transfer switch regardless of the condition or position of the switch. Switches shall be double-throw, actuated by (2) electric operators. Each transfer switch shall have an inherent “off” position for shedding the load in the event of an engine generator failure.

A programmable microprocessor shall be provided for automatic exercising.

Equipment shall be manufacturer by Russelectric or ASCo.

Load Bank:

A load bank will not be provided due to construction budget constraints.

Emergency Equipment Rooms:

The emergency generator, switchgear, and transfer switches shall be located in dedicated 2-hour fire rated rooms independent of one another and other electrical equipment such as the substation.

UPS Equipment:

A central UPS system is not anticipated.

LIGHTING SYSTEMS DESIGN CRITERIA

Lighting Levels:

All lighting shall meet the current requirements of Title 24 energy conservation standards.

Lighting levels shall conform to the Illuminating Engineering Society's recommendations. The targeted lighting levels are as follows:

Administration/ Office/ Open Workstations	50-70	fc
Classrooms	60-75	fc
Auditoriums/ Distance Learning Suites	60-75	fc
Workrooms	40-60	fc
Circulation/ Lounges/ and Restrooms	15-25	fc
Storage/ Support Rooms	15-25	fc
Labs	60-80	fc
Clean Room – Clean Aisles	75-100	fc
Clean Room – Service Aisles	50-75	fc
Mechanical/ Plumbing/ Elect. Equipment Rooms	25-40	fc
Exterior	1	fc

Lamps and Ballasts:

Generally, fluorescent lamps shall be 4 foot rapid start with a 3500°K color temperature, with a minimum color rendering index of 75. Lamps shall be T8 in recessed fixtures and T5 in suspended linear fixtures.

Incandescent lamps shall be the energy savings type, long life, rated for 130 volts.

Ballast shall meet State of California standards, be UL listed and be high-frequency solid state, high power factor, class A with auto-resetting built-in thermal protection. Electronic ballasts shall have a maximum total harmonic distortion of 10 percent.

DESCRIPTION OF LIGHTING SYSTEMS

A complete lighting system for all indoor and site illumination shall be provided. The indoor lighting system shall consist of energy efficient fluorescent fixtures. Incandescent fixtures will be provided in selected areas.

UCR standard pole-mounted, metal halide lighting fixtures and poles shall be used along pathways and sidewalks.

Exit signs shall be State Fire Marshall approved LED type, located in all paths of egress in accordance with requirements of California Title 24.

Emergency/night lighting shall be provided by unswitched branch circuits. These unswitched branch circuits shall be fed from emergency lighting panel.

Lighting Fixtures:

Administration/ Office/ Open Workstations	*Ceilings under 9'-6" ft:* Recessed, deep cell, parabolic, static, fluorescent troffers. *Ceilings 9'-6" ft. and higher:* Suspended, linear, direct/ indirect, steel, fluorescent luminaries.
Classrooms	*Ceilings under 9'-6" ft:* Recessed, deep cell, parabolic, static, fluorescent troffers. *Ceilings 9'-6" ft. and higher:* Suspended, linear, direct/ indirect, steel, fluorescent luminaries.
Auditoriums/ Distance Learning Suites	Suspended linear direct luminaires for general assembly lighting, wall washers, down lights over the podium, and spot lights for the white boards.
Labs	*Ceilings under 9'-6" ft:* Recessed, deep cell, parabolic, static, fluorescent troffers. *Ceilings 9'-6" ft. and higher:* Suspended, linear, direct/ indirect, steel, fluorescent luminaries.
Clean Room	*Surface Mounted*: sealed fluorescent fixtures with stainless steel body and tear dropped shaped virgin acrylic prismatic lens. *Recessed:* static, clean room grade, sealed, stainless steel, fluorescent troffers with virgin acrylic prismatic lenses. *Embedded*: fluorescent fixtures embedded within the HEPA filter assembly. *Note: UV limiting, amber lenses will be provided where required.*
Workrooms	Recessed, deep cell, parabolic, static, fluorescent troffers.
Circulation/ Lounges/ and Restrooms	Premium quality architectural ceiling and wall mounted fluorescent luminaires.
Storage/ Support Rooms	Surface mounted wraparound fluorescent fixtures.

Mechanical/ Plumbing/ Electrical Equipment Rooms	Suspended, open, industrial type, strip fluorescent fixtures.

The lighting fixtures and descriptions above are general in nature and shall be validated and further refined in the following phases of work.

Lighting Control System:

All lighting will be controlled to meet or exceed the requirements of California Title 24 including, but not limited to, building lighting shut-off, dual level switching and daylight switching.

In general, lighting controls shall consist of low voltage relays controlled by the lighting control system, and room sensors. Outdoor lighting controls shall be controlled by photocells and time of use programming.

Switch control shall be provided for each room and multiple switch controls (minimum [2] switches) for rooms over 100 sq. ft.

Light switches for lobbies, corridors, stairwells and similar circulation areas shall be provided to accommodate persons entering or leaving the building at night. Switches shall be installed to turn on lights ahead and turn off lights behind as people move through the building. Override switches shall be provided at each elevator landing to control corridor lights.

Dimming systems shall be provided in all auditoriums, distance learning spaces and conference rooms as required.

Occupancy sensors shall be utilized in all offices, equipment rooms, classrooms, circulation areas, lounges and other spaces in which occupants are not likely to turn off lights.

GROUNDING SYSTEM DESCRIPTION

A complete equipment grounding system shall be provided such that all metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, metal fences, and all other conductive items operate continuously at ground potential and provide a low impedance path to ground for possible fault currents. Ground system resistance shall be 5 ohms or less.

The reference ground for the equipment grounding system shall be established from a structural ground grid as follow:

1. A No. 4/0 AWG bare copper ground wire shall be installed at 30” below grade around the entire perimeter of the building. ¾” x 10’ driven

copper clad ground rods (test wells) shall be installed and connected to this ground loop at not greater than 200 foot intervals with a No. 4/0 AWG bare copper conductor. Steel columns in exterior walls shall also be connected to this ground loop at intervals not to exceed 60 feet. Interior steel columns shall be connected to the exterior ground loop on each side of the building at intervals not to exceed 200 feet with a No. 4/0 AWG bare copper conductor.

2. A wall mounted copper ground bus shall be located in the main electrical room and floor electrical rooms. The main electrical room ground bus will be connected to the exterior ground loop and a separate insulated ground wire in conduit shall be provided from the main electrical room ground bus to each floor electrical room ground bus.

3. A No. 4/0 AWG bare copper grounding electrode conductor shall be extended to all telephone closets, so that those systems can be properly bonded.

4. A ground bus will be provided within the clean room service aisle. A no. 4/0 cable will interconnect the ground bus to the main electrical service ground.

5. Conductive flooring in the clean room and Telecommunications rooms will be grounded.

A separate insulated green grounding conductor shall be provided for each single and 3-phase feeder and branch circuit. Grounding conductor shall be run with the related phase and neutral conductors. Panel feeders installed in more than (1) raceway shall have individual, full sized, green grounding conductor in each raceway. The equipment grounding system shall not rely on the metallic raceways for grounding continuity.

Ground busses shall be included in each Tel/Data room.

FIRE ALARM SYSTEM DESCRIPTION

The fire alarm system would utilize addressable, microprocessor-based system, with cabinets, power supplies, micro-controller, keyboard display, led display, batteries, peripheral devices, firefighter’s telephones, etc. The system shall be manufactured by Simplex, the campus standard. The need for a voice evacuation system needs to be determined in the subsequent phases.

Control Panel:

The main control panel shall be a solid-state, microprocessor-based, modular fire alarm control panel. The control panel shall communicate with all peripheral initiating devices and each initiating device shall report to the control panel with an individual device point number and message.

The control panel shall receive all alarms from peripheral devices and remote data gathering panels, initiate a pre-recorded voice message throughout the facility, and indicate alarm on the floor of incident and the floor above.

Atrium Smoke Control Panel:

The fire alarm system would be equipped with a separate smoke control panel serving the atrium if an atrium is included in the project. H-O-A switches and positive status annunciation shall be provided for each associated fan and damper. The emergency generator will need to increase in size if this is incorporated into the design.

Remote Data Gathering Panels (DGP):

Remote data gathering panels shall be located on each level for fire alarm service termination in the floor on which it's located. DGP's shall communicate directly with the main fire alarm control panel and fire command center. Each remote DGP shall be a fully functional self-contained and self-sufficient unit such that, if the connection to the control processor is severed, (a trouble indication shall sound) the panel will continue to function and sound appropriate alarms based on the last set of programming instructions received.

Manual Pull Stations:

Manual pull stations shall be provided at each floor egress and shall be spaced, such that the travel distance to any pull station is less than 200'-0".

Pull stations shall be double-action of the non-coded type with a key reset switch.

Smoke Detectors:

Smoke detectors shall also be located within stairwells, atriums, elevator vestibules, electric rooms and other locations as required by code. Smoke detectors shall be photoelectric type. Duct smoke detectors shall be located at each air-handling unit and at combination fire smoke dampers shall be the photoelectric type.

Smoke detectors will operate an alarm verification function via software that will require two (2) smoke detectors to initiate an alarm condition before activating alarm indicating devices.

Heat Detectors:

Heat detectors shall be provided in mechanical and emergency generator rooms.

Flame Detectors:

Ultraviolet flame detectors will be provided for the monitoring of pyrophoric (Silane) dispensing stations.

Very Early Smoke Detection Apparatus (VESDA):

Early warning detection devices shall be provided to monitor the clean room spaces within the return air chases. These devices detect fire before visible smoke or flame is apparent. The system consists of a series of inconspicuous tubes which carry samples of air from a protected space to a highly sensitive, laser based, detector. The detector transmits a signal to a controller which can generate alarms at four different points along a bar graph display of the signal. The first two alarm levels alert in-house personnel to a possible fire condition. The third, and last, alarm level will report an alarm conditioning to the building fire alarm control panel.

Elevator Recall:

Alarm initiation shall signal all elevators to recall to a designated floor.

Alarm Indicating Devices:

Visual strobe units shall meet the requirements of ADA, UL and NFPA. A strobe unit shall be provided at locations dictated by code.

Audible units in public spaces shall be speakers with a peak output of 96 dB at 10'-0".

Audible units in mechanical areas or other areas with high ambient noise shall be trumpet type suitable for such locations.

Wiring:

All fire alarm wiring shall be Style 6 (Class "A") and supervised. All wire and cable shall be suitable for fire alarm use and shall be installed in conduit.

MICROFAB AIR IONIZATION

Air ionization systems within the clean spaces will be provided as required by the Functional Design Criteria.

SECURITY SYSTEM DESCRIPTION

Security system provisions shall be provided in accordance with the UCR standards such that wiring and equipment can be installed by the security system vendor.

Card access shall be provided at main entrances and at special interior areas requiring controlled access to be determined during detailed design.

Other security features:

1. Electric mortises and electrified panic hardware
2. Egress shall be shunted via motion detectors
3. Door alarm contact shall be flush mounted on the door header
4. Cabling for electric mortise hardware shall be wired through the hinge-side of door

Security components and panels will not be located in mechanical rooms or electrical rooms.

TESTING

All high voltage equipment, cable and transformers shall be hi-pot tested per NETA standards and recommendations.

All low voltage 600V equipment, cables, motors, dry type transformers, etc., shall be field tested per NETA standards and recommendations.

ELECTRICAL STUDIES

Detailed (node-to-node) short circuit and coordination studies of the entire normal and emergency power distribution systems shall be provided.

A detailed harmonic analysis, in accordance with IEEE 519, shall be provided by the manufacturer of the variable frequency drives.

CONCEPTUAL (PRELIMINARY) MAJOR ELECTRICAL DISTRIBUTION EQUIPMENT SCHEDULE

Equipment	***Size (Each)***	***Total Quantity***	***Remarks***
<u>Double-Ended Unit Substation</u>			
SF_6 Sectionalizing Switch	15 kV, 600 Amps	2	6-way G&W RAM switch.
Unit Substation Transformers	2,000 kVA, 12 kV Primary –480Y/277V, 3 ph, 4-wire Secondary	2	115°C VPI, dry type, fan cooled with surge arresters.
Secondary Switchgear	3,000A, 480Y/277V, 3 ph, 4-wire.	2	Draw-out power main and feeder breakers
Tie Breaker and Busway	3,000A, 480Y/277V, 3 ph, 4-wire	1	
Full Function Electronic Metering	N/A	2	Interface with Campus system.
480/277V Distribution Switchboards	1200A main lugs, 480/277V, 3 ph, 4-wire	TBD	
Vertical Distribution Busways & Bus plugs	480/277V, 3 ph, 4-wire + ground.	TBD	Provide ground fault protection at each bus plug.
Lighting Panels	42 circuit, 225A main lugs, 3 ph, 4-wire + ground.	1/ Floor	
Distribution Step Down Transformers	480V primary, 208Y/120V 3 ph, 4-wire Secondary	500 kVA (total)	Dry Type, K-6 rated, distributed thru the building
Distribution Power Panels	400A main breaker, 3 ph, 4-wire + ground.	TBD	
Lab Panels	42 circuit, 225A main breaker, 3 ph, 4-wire + ground.	1/ Double Lab Module	
Clean Room Distribution	TBD	500 KVA (total)	
Receptacle Panels	42 circuit, 225A main breaker, 3 ph, 4-wire + ground.	1/ 5,000 ASF	Also provide one additional panel per computer room.

Mechanical/ Plumbing Equipment			
Motor Control Centers	600A, 480V, 3 ph, 4-wire, NEMA class II-B	TBD	
Variable Frequency Drives	12-pulse, IGBT drives	TBD	In compliance with IEEE 519
Emergency Power Generation and Distribution			
Generator	1000 kW, 277/480V, 3 ph, 4-wire	1	Diesel driven with on-site fuel storage for 24 hours.
Emergency Distribution Switchboard	1600A mains lugs, 3 ph, 4-wire	1	
Automatic Transfer Switches	400-800A, 277/480V, 3-ph, 4-pole	3	With Bypass Isolation Feature
Emergency Distribution Power Panels	400A main lugs, 3 ph, 4-wire + ground.	TBD	
Emergency Lighting Panels	30 circuit, 100A main lugs, 3 ph, 4-wire + ground.	1/ Floor	
Distribution Step Down Transformers	480V primary, 208Y/120V 3 ph, 4-wire Secondary	TBD	Dry Type, K-6 rated, distributed thru the building
Emergency Receptacle Panels	30 circuit, 100A main breaker, 3 ph, 4-wire + ground.	TBD	
Emergency Equipment Panels	42 circuit, 225A main breaker, 3 ph, 4-wire + ground.	TBD	

END OF SECTION

6.3 Plumbing / Fire Protection

DOMESTIC PLUMBING SYSTEMS

Design Philosophy:

The intent of this section is to promote the implementation of cost effective and energy efficient strategies for systems design and arrangements, equipment selection, distribution, and overall systems integration. These strategies will be undertaken during subsequent design phases.

Plumbing system components and distribution layouts shall have the following characteristics:

1. Protection of the public water supply
2. User safety and comfort
3. Universal accessibility
4. Modular approach
5. Energy responsiveness
6. Flexibility for future changes
7. Durability
8. Ease of maintenance
9. Reliability
10. Redundancy of critical components

Every effort shall be made to design, layout and install equipment in locations which will tend to encourage routine preventative maintenance by providing easy access for maintenance personnel. Manual isolation valves will be provided to enable servicing, expansion of, renovation or construction of any part of the facility without unscheduled interruption of services in adjacent areas.

All systems, equipment and fixtures shall be designed in accordance with the California Building Code, applicable local Codes and Ordinances, NFPA and the University Design Guidelines.

Sustainability:

Refer to the HVAC section (6.1) of this report for discussions related to the MEP aspects of sustainable design.

APPLICABLE CODES

The codes and standards listed below are minimum requirements. In specific instances, the design may exceed the applicable requirements.

1. California Building Standards Administrative Code (Title 24, Part 1), 1998
2. California Building Code (Title 24, Part 2), 1998
3. California Plumbing (Title 24, Part 5), 1998
4. California Energy Code (Title 24, Part 6), 1998 edition with 2001 energy regulations.
5. California Fire Code (Title 24, Part 9), 1998
6. California Referenced Standards Code (Title 24, Part 12), 1998

Note: The above code applicability must be reviewed and updated for applicable codes at the time of permitting.

The DPP assumes that the clean room component of the project will not be classified as an H-6 occupancy.

REFERENCES AND STANDARDS

1. Local Ordinances, Regulations of the Local Building Department and Fire Department
2. Recommendations of the National Fire Protection Association (NFPA), latest applicable edition adopted, in general and in particular:
3. Life Safety: NFPA 101
4. HVAC: NFPA 90A and 90B
5. Laboratory Systems: NFPA 45
6. Fuel Oil: NFPA 30 and 37
7. NIH 93-8395: Biosafety in Microbiology and Biomedical Laboratories
8. NIH: Design Policy and Guidelines, Bethesda, MD, February 1996.
9. ILAR: Guide for the Care and Use of Laboratory Animals, 1996.
10. UL: Underwriters Laboratories, Inc.

Note: The above code applicability must be reviewed and updated for applicable codes at the time of permitting.

DESIGN CRITERIA

Water Consumption of Plumbing Fixtures:

1.	Water Closet:	1.6 gallons per flush
2.	Public Lavatory:	0.5 gpm
3.	Sink:	1.5 gpm
4.	Urinal:	1 gallon per flush

Water Supply:

Provide a new domestic water service and connect to the municipal system. Protect the new service with duplex building containment reduced pressure backflow preventers located on the exterior of the building. An exterior water meter shall be provided.

Water supply pressure within the system shall be maintained between 35 psi minimum and 80 psi maximum at all points. A multiple station pressure reducing valve assembly will reduce incoming service pressure from 175 PSI to 80 PSI.

Potable water shall be distributed to all domestic fixtures (including wash rooms) and shall be protected from contamination by the use of code approved cross connection control devices and practices.

Hot Water Supply:

Provide a new potable hot water system to serve the facility.

Potable hot water will be generated centrally by duplex semi-instantaneous steam to water heat exchangers and a master thermostatic mixing valve. This system will provide hot water to all domestic fixtures.

Hot water shall be distributed throughout the building at a temperature of 120°F. A hot water return system shall be provided to maintain the hot water supply temperature. A hot water recirculation pump shall be provided, it shall operate when the temperatures of the hot water system drops to 110°F.

Non-potable (Industrial) Hot and Cold Water:

A non-potable water sub-service will serve hot and cold water to the laboratory and clean room areas and will be protected by duplex in-plant reduced pressure principle backflow preventers.

Protected non potable hot water will be generated centrally by duplex semi-instantaneous steam to water heat exchangers and a master thermostatic mixing valve. This system will provide hot water to all laboratory equipment and other non-domestic facilities. Hot water will be distribution at a temperature of 120°F. A hot water return system will be provided to maintain the hot water supply temperature.

Sanitary Drainage System:

Provide a complete sanitary waste and vent system throughout the building serving the toilet rooms, mechanical equipment and floor drains. Systems shall run by gravity flow wherever possible. Building drains which cannot be discharged by gravity flow will be collected into a duplex sewage ejector system from which the effluent shall be lifted and discharged into the gravity drainage system. All of the sanitary waste and vent systems shall be cast iron pipe. The ejector pumps shall be connected to the emergency power system.

Laboratory Drainage System:

A complete laboratory waste and vent system shall be provided throughout the laboratory areas in the building and shall be separate from the building sanitary system as required by code.

Laboratory sinks, cup sinks and equipment shall be connected by gravity to the laboratory waste system, utilizing polypropylene piping which will exit the building independent of the sanitary waste system. Laboratory vent piping shall also utilize polypropylene pipe and shall run through the roof independent of the sanitary vent system. The laboratory waste effluent will discharge through an exterior pH testing manhole prior to connection to the campus sewer.

Clean Room Drainage System:

A complete clean room waste and vent system shall be provided and shall be separate from the sanitary and laboratory drainage systems.

All microfabrication tools shall be connected by gravity to the clean room waste system using double wall polypropylene piping. Clean room vent piping shall also utilize double wall polypropylene piping and shall run through the roof independent of the sanitary and laboratory vent system.

A clean room waste treatment system shall be provided. The central neutralizing unit will consist of two (2) tanks, in series that receives all clean room waste, complete with a control unit, sensor in the central waste tank to sense the acid or alkaline rating to the tank contents. Adjacent to the tank control unit, there will be two (2) tanks with pumps. One (1) tank will be filled with a liquid acid neutralizing agent and the other tank with an alkaline neutralizing agent. The control unit will automatically add the proper amount of acid to bring an alkaline solution down to neutral 7.0 or the proper amount of alkaline to bring an acid solution up to neutral 7.0. A sensor operated recording device shall also be provided on the waste line prior to connection with the sanitary sewer. The control system shall operate to discharge liquid waste in a range of 6.5 to 8.6 pH or as required by the Local Sewer Authority.

Rainwater Drainage System:

Provide a complete gravity storm drainage system in the building. The system shall connect to each roof drain and area drain, including collection from the underslab drainage. Storm drains which cannot flow by gravity will be collected in a duplex sump pump system. The underslab foundation drainage system will connect to the duplex sump pump system through a sediment settling pit. The effluent from the sump pump will connect to the gravity system. The sump pumps shall be connected to the emergency power system.

The storm drainage system shall be sized to remove rainwater from the building's roof. The system size shall be based upon local rainfall rates. A secondary overflow drainage system shall be provided that consists of either redundant piping with discharge on to grade, or scuppers.

Natural Gas:

The natural gas system shall be an extension of the municipal distribution system to the building and will be equipped with a meter and regulator. The building distribution system shall be supplied from the meter through the foundation wall and distributed to the laboratories. The distribution system shall include all piping, fitting, valves, vents, regulators and connections.

The natural gas system shall be designed to provide 5 cfh per outlet with a maximum system pressure drop of 0.5 inches water column.

Compressed Air:

Laboratory and clean room compressed air will be generated centrally via a complete factory packaged triplex clean dry air compressor system with duplex desiccant dryers, storage tank, and final filters located in the mechanical room. Air compressor intake shall be located on the roof away from all HVAC exhaust, plumbing vents, vacuum exhaust or any other equipment exhausts. The system shall provide a minimum 100 psig at the furthest clean room outlet and 50 psi at the furthest laboratory outlet. All compressed air piping and valves shall be provided washed, capped and cleaned for oxygen service. A central pressure reducing valve shall be located at the compressor to reduce the air pressure for the laboratory usage. The laboratory and clean room compressed air piping shall be dedicated and separated at the source equipment.

Central Vacuum:

A complete central laboratory and clean room vacuum system located in the mechanical room of the new building shall be provided. The system shall be a packaged triplex dry vacuum pump assembly. The system shall be connected to the outlets and shall provide 24" Hg at each outlet. The central vacuum exhaust will run independently through the roof.

The central vacuum system shall provide vacuum to all laboratories and clean room areas as required. The system shall be sized to provide 24" Hg at each of the vacuum outlets, with a total system pressure drop of 4" Hg. The vacuum piping to the laboratories and clean rooms shall be dedicated and separated at the source equipment.

RODI Water:

A complete central reverse osmosis and deionized water (RO/DI) system with a continuous loop will be provided throughout the laboratories and to the clean room. The system is intended to provide CAP Type II (3 to 10 megohm/ cm) water to the laboratories and electronic grade (E-1, 18.2 megohm/cm) water to the clean room. This system shall include a common mixing valve, multi-media, duplex water softeners, carbon filters, carbon recirculation skid and skid mounted RO system with dedicated laboratory and clean room storage tanks, mixed bed deionizers, controls, PLC control panel and re-pressurization pumps. Each system will include all piping, valves and filters to make a complete system. The system shall include socket fused polypropylene piping with zero static diaphragm valves.

Tempered Water:

A tempered water system for emergency water supply is not anticipated due to the tepid temperature of the incoming cold water system. However, this will be required to be verified at the time of the detailed design phase of the project. The potable cold water distribution system shall supply all emergency showers and eyewashers.

Fuel Oil:

Fuel oil shall be supplied from an underground double wall steel or fiberglass tank with all required components including leak detection, fuel level monitoring, valves, fill opening, controls, manholes, tappings and pumps to supply the emergency generator.

Duplex fuel oil pumping package shall be complete with rupture tank, sensors, controls, valves, gauges, including a day tank. Day tank shall be a package type with rupture tank, valves, controls, sensors and tappings. The day tank shall be located adjacent to the emergency generator and piped with valves, strainers and flexible connections with a capacity for a minimum 24 hour run time.

Nitrogen and Specialty Gases:

Gaseous nitrogen shall be supplied from a new bulk nitrogen tank located exterior of the building. The tank shall be furnished under a lease arrangement with the gas supplier. The building distribution system shall originate from the vaporizer at the bulk tank and distribute to the clean room. The gaseous nitrogen system shall be provided as required with all piping and valves being stainless steel with orbital arc welded fittings.

Specialty gas systems shall be provided as required with all valves, piping and regulators. The systems will be located on each laboratory floor. All piping and valves shall be provided capped and cleaned for oxygen service.

House Cleaning Vacuum:

A house cleaning vacuum system for the clean room may be required. This criteria will be evaluated during the design phase of the project.

Laboratory Equipment:

All prefabricated sink countertops, cabinet work, and other equipment or furnished will be furnished and installed be the Laboratory Equipment Contractor. The Plumbing Contractor will install all faucets gas, vacuum and compressed air outlets. In general, all sinks shall be integral with countertop and set in place complete with waste outlet. The Plumbing Contractor shall be responsible for final installation of lab trim and the waste and vent lines from the sink and outlets.

All hoods will be furnished and installed by the Laboratory Equipment Contractor, and shall be erected in place, complete with all integral piping, ready for service connections, including waste, by the Plumbing Contractor.

Safety Equipment:

Emergency showers/eyewashers shall be provided at the laboratory exits. Laboratory sinks shall be provided with eyewash units.

Supply piping shall be from the potable cold water system. The system design shall be based on ANSI Guidelines.

PLUMBING EQUIPMENT:

Two (2) reduced pressure backflow preventers (Watts 909), shall be provided on the building service (connected in parallel) for building containment and to protect the municipal water main.

Two (2) reduced pressure backflow preventers (Watts 909), shall be provided for the non-potable water systems (in parallel) for in-plant protection and to protect the building's potable water system.

One (1) reduced pressure backflow preventer (Watts 909), shall be provided for the supply to the high purity water system and (1) 2“ reduced pressure backflow preventer provided for the mechanical equipment make-up water needs.

Hot Water:

Steam to water semi instantaneous water heater shall be provided with a hot water recirculating system and 140°F main thermostatic mixing valves.

Non-potable Hot Water:

Steam fired, semi-instantaneous water heater shall be provided with a hot water recirculating system and 140°F main thermostatic mixing valves.

RO/DI System:

Complete pre-treatment system including multi-media filters, duplex softeners, carbon filter, UV sterilizer and 5 micronfilter. The pre-treatment system shall be common to the laboratory and clean room systems.

RO make-up unit to be determined.

Laboratory and Clean Room:	1500 gallon polypropylene storage tank with level switches and hydrophobic vent filter.
Laboratory and Clean Room:	Mixed bed deionizer tanks with 5 micron resin traps.
Laboratory:	80 gpm distribution skid with UV sterilizer duplex pumps and final 0.2 micron filters.
Clean Room:	240 gpm distribution skid with one TOC UV sterilizer, 0.02 micron final filter and duplex 240 gpm distribution pumps.

Laboratory and Clean Room Air Compressor:

Triplex clean dry air, oil free, permanently lubricated, reciprocating, 30 HP each, capable of 116 cfm at 125 psi. Duplex desiccant dryers with dewpoint monitor, final coalescing filters and duplex regulating valves. Ingersoll Rand, Quincy or Atlas Copco

Laboratory and Clean Room Vacuum:

Triplex dry type, 15 HP each, capable of 115 acfm at 24" Hg. Busch or Kinney.

Piping Insulation:

Owens Corning ASJ SSL, pre formed piping insulation of 4 pound density fiberglass with ASJ/self sealing lap shall be provided. Fittings shall be insulated with loose fiberglass and covered with pre formed PVC jacket. Insulation thickness shall be in accordance with the following:

Potable and Non Potable Hot Water Supply and Return:	1”
Indirect Waste:	1/2"

(Cold water shall be insulated in the mechanical rooms in accordance with the University's standards).

At each support, provide a 12" long segment of non compressible insulation with jacket to match adjacent covering.

Clean Room Waste Neutralization System:

The following components shall be provided for the clean room waste and neutralization system:

- 1,000 gallon polyethylene pre-treatment tank with agitator
- 1,000 gallon polyethylene trim tank with agitator
- Caustic tank with two (2) injection pumps
- Acid tank with two (2) injection pumps
- Control panel with constant monitoring devices and paper chart recorder
- Discharge monitoring sensor probe
- Associated piping, valves, wiring and sensors

SYSTEM TESTING

All systems shall be tested in accordance with the requirements of the Authorities having jurisdiction, and NFPA requirements. As a minimum, all pressure piping systems shall be tested at 150% of the normal working pressures.

FIRE PROTECTION SYSTEMS

Design Philosophy:

The intent of this section is to promote the implementation of cost effective and energy efficient strategies for systems design and arrangements, equipment selection, distribution, and overall systems integration. These strategies will be undertaken during subsequent design phases.

The new Fire Protection systems shall have the following characteristics:

1. Occupant and building safety
2. No adverse effect on public water supply
3. Flexibility for future changes
4. Durability
5. Ease of maintenance
6. Reliability and Redundancy

Every effort shall be made to design, lay out and install equipment in locations which will tend to encourage routine preventative maintenance by providing easy access for maintenance personnel. Manual isolation valves will be provided to enable servicing, expansion of, renovation or construction of any part of the facility without unscheduled interruption of services in adjacent areas.

All systems and equipment shall be designed in accordance with California Building Code, recommendations of the National Fire Protection Association (NFPA), the University Guidelines, and the Owner's insurance underwriter.

APPLICABLE CODES

The codes and standards listed below are minimum requirements. In specific instances, the design may exceed the applicable requirements.

1. California Building Standards Administrative Code (Title 24, Part 1), 1998
2. California Building Code (Title 24, Part 2), 1998
3. California Plumbing (Title 24, Part 5), 1998
4. California Energy Code (Title 24, Part 6), 1998 edition with 2001 energy regulations.
5. California Fire Code (Title 24, Part 9), 1998
6. California Referenced Standards Code (Title 24, Part 12), 1998

Note: The above code applicability must be reviewed and updated for applicable codes at the time of permitting.

The DPP assumes that the clean room component of the project will not be classified as an H-6 occupancy.

REFERENCES AND STANDARDS

1. Local Ordinances, Regulations of the Local Building Department and Fire Department
2. Recommendations of the National Fire Protection Association (NFPA), latest applicable edition adopted, in general and in particular:
3. Life Safety: NFPA 101
4. HVAC: NFPA 90A, 90B
5. Automatic Sprinklers and Standpipes: NFPA 13 and 14
6. Laboratory Systems: NFPA 45
7. Fuel Oil: NFPA 30 and 37
8. UL: Underwriters Laboratories, Inc.

DESIGN CRITERIA

The fire protection system shall be designed as follows:

Class I standpipes with 2-1/2" fire department valves shall be located in all exit stairwells.

Sprinklers shall be provided throughout the building to protect all areas, including electric rooms and elevators. Sprinklers in elevator shafts shall be provided with a shutoff valve and flow switch on the branch line.

All sprinklers shall be hydraulically designed to meet NFPA 13 and 318, and the Owner's Insurance Underwriter criteria.

The system shall operate from municipal water pressure (approximately 175 PSI). The building is not a high rise and the emergency water storage tank and a fire pump is not anticipated.

Sprinkler Densities:

Classrooms and Offices:
Ordinary Hazard Group I 0.15 gpm per sq.ft. over the most remote 1,500 sq.ft.

Materials Labs and Dry Labs:
Ordinary Hazard Group II 0.18 gpm per sq.ft. over the most remote 3,000 sq.ft.

Clean Rooms:
Ordinary Hazard Group II 0.20 gpm per sq.ft. over the most remote 3,000 sq.ft.

Process Gas Dispensing Areas:
Extra Hazard Group 2 0.38 gpm per sq.ft. over the most remote 3,000 sq. ft.

This document describes the minimum requirements that must be met for the installation of the Fire Protection work and represents the overall concept of the Fire Protection system and are not intended to present all devices that will ultimately be required to serve the building.

The following is a general system description and associated equipment which shall be provided for the building.

1. A complete fire protection system will be provided, including the new water service, double detector check valve assembly, Class I standpipes and sprinklers. The system shall be in accordance with all authorities having jurisdiction.

2. The sprinkler system shall be hydraulically designed and installed as per NFPA 13 and 318.

3. Zoned protection of elevator shaft and machine rooms, gas cabinets and laboratory areas shall be provided.

4. The clean room sprinkler system shall be supplied from a dedicated main alarm valve and shall be separate from the base building sprinkler system.

5. Microfabrication tools may require dedicated fire suppression systems such as FM-200 or Fine Water Spray (FWS) using deionized water. Sprinkler protection below raised floors, within plenums, within plastic or combustible ductwork and within gas storage cabinets shall be provided.

SYSTEMS

The entire facility will be provided with a combination "wet" standpipe and sprinkler system. Source of water will be as noted above. The system will include a fire department connection, located for convenient Fire Department access.

The combined standpipe/sprinkler system shall have 2 1/2" Fire Department Valves (FDVs). In general, all 2 1/2" valves will be inside fire rated stairways to allow Fire Department personnel to access a fire from the stairway. All valves will have the same hose thread as per the local Fire Department requirements. At the ceiling and within the stairwell of each floor, each riser shall be provided with a floor zone control valve, complete with vane type flow alarm, inspectors test station and supervised shut-off valve to serve the sprinkler system.

Flow Test:

A flow test to verify hydraulic performance of the site system shall be conducted during the project design. Flow test will be run at times, as directed by Owner and Local Authorities.

Pipe And Fittings:

Sprinkler piping in the cleanroom areas shall be copper tubing or galvanized steel.

Sprinkler Heads:

Sprinklers in hung ceilings shall be quick response semi-recessed type with chrome escutcheons.

Sprinklers in areas without ceilings shall be upright quick response type with brass finish.

Clean room and process gas dispensing room sprinkler shall be standard response type. All gas cabinets shall be protected with an interior mounted sprinkler.

All heads shall be UL listed and FM approved type.

Backflow Preventer:

Unit shall be in conformance with local regulations. Unit shall be installed exterior of the building on the incoming water service.

SYSTEM INSTALLATION

The entire facility shall be sprinkled in accordance with the Authorities having jurisdiction, including the Owner's Insurance Underwriter, Local Fire Department, and NFPA Guidelines. The system shall be installed in accordance with these Guidelines, including all skylights, atriums, penthouses and basements.

All piping systems and equipment shall be identified in accordance with current ANSI Standards.

SYSTEM TESTING

All systems shall be tested in accordance with the requirements of the Authorities having jurisdiction, and NFPA requirements. As a minimum, the systems shall be tested at 200 psi.

END OF SECTION

6.4 Telecommunications

TELECOMMUNICATIONS SYSTEMS

A complete empty raceway system shall be provided for pulling in Telecommunications wiring. The system shall meet the EIA/TIA-569 standards.

Network hubs and switching will be provided.

Incoming Telecommunications Service:

Four (4) 4" PVC Schedule 40 conduits and (1) 7-cell, air blown, fiber duct encased in concrete shall be run from designated vault 12 on the site to the main Communications Service Entrance Room (CSER). The CSER shall be a minimum of 150 square feet.

Multiple Communications Service Distribution Closets (CSDC) shall be provided on each floor and shall be a minimum of 100 sq. ft. The rooms shall be located so that the cabling length from the farthest outlet will not exceed 250 feet.

CSER and CSDC rooms shall be stacked for the convenience of running wiring and cables from one floor to the next through sleeves. Each CSDC shall have a minimum of three 4” sleeves/conduits from the main telecommunications room.

The CSER and CSDC rooms shall be provisioned with individual control of 24hr HVAC, emergency power receptacles, a convenient connection to the building grounding electrode system, fire retardant plywood material on the walls, lighting, and access control.

All rooms and closets shall have adequate space, ventilation and cooling to handle active networking equipment in standard 19” racks.

Distribution:

From each satellite closet on each floor, a system of cable tray and conduit shall be utilized for the distribution of telecommunications wiring to the end use equipment.

Cable Trays:

A system of cable trays shall be provided consisting of ladder type tray run in the central corridors. Cable tray shall be sized sufficient to handle the weight of all cables and wires to be installed.

Where cable tray penetrates fire or smoke partitions the tray shall terminate into 4" conduit sleeves, quantity to be equal in areas as the cable tray.

Telecommunications Outlets:

Each telecommunication outlet shall consist of a 4-11/16 inch square outlet box 2½" deep with single gang mud ring. A 1-1/2" conduit shall run from the outlet to over the edge of the cable tray and be mechanically grounded to the tray and terminated with a bushing. Provide 2 data jacks and 1 voice jack at each device location. Telecommunications wiring will be provided per University Standard.

Outlets shall be provided in the following locations:

Offices & Administration

1. One (1) combination telephone/data outlet at each work station or (1) per 40 square feet.

Dry Laboratories

1. One (1) combination telephone/data outlet at each work station or (1) per 25 square feet.

Wet Laboratories

1. One (1) combination telephone/data outlet at each technician desk.
2. One (1) data outlet at each laboratory bench on service column or in surface duct.
3. One (1) telephone outlet at laboratory entrance.

Clean Room

1. A minimum of one (1) combination telephone/data outlet per 50 square feet within both the clean and service aisles.

Telecommunications Backboards:

Telecommunications backboards shall consist of the appropriate number of 8' by 4' by 3/4" plywood backboards.

END OF SECTION

6.5 Audio/Visual Technology

AUDIO/ VISUAL SYSTEMS

The design of the building will include the complete integration of a comprehensive network of pathways for audio/visual and telecommunications technology.

6.6 Building Structure

STRUCTURAL SYSTEMS

1.0 Project Description:

The project consists of a 4-story laboratory building with 3-story classroom/lecture hall component. The building comprises of approximately 134,000 gsf, which includes approximately 21,020 asf of classroom/lecture hall. The program includes a combination of wet and dry research laboratories and support spaces, faculty and student offices, and classroom/lecture hall.

2.0 General Design Criteria

2.1 Codes

The governing building code will be the California Building Code, 2001 edition. Other referenced design codes are anticipated to include the AISC Manual of Steel Construction *(LRFD)*, Second Edition, ACI Building Code, Commentary, ACI 318-99, and AWS Structural Welding Code, ANSI (AWS D 1.1-98).

1.2 Design Loads

1.2.1 Live Loads:

Laboratories	125 psf, fully reducible for columns and foundations
Offices	100 psf, fully reducible
General Storage	125 psf, non-reducible
Circulation Areas	100 psf, non-reducible
Main Roof (general)	20 psf reducible
Penthouse Roof	20 psf reducible

1.2.2 Dead Loads

General:	Estimated weight of construction material.
Mechanical Equipment:	150 psf or weight of mechanical equipment.

1.2.3 Seismic Design

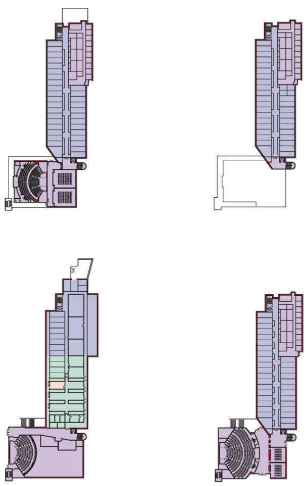
Seismic design criteria will be based on the latest edition of the California Building Code (2001) and the University of California Seismic Safety Policy, which requires that the building attain a seismic rating of “GOOD”.

Seismic Zone Factor	Z = 0.4
Importance Factor	I= 1.15
Soil Profile Type	S_D
	C_a = 0.44, N_a = 1.0
	C, = 0.69, N_v, = 1. 1

Structural System Factor
Will depend on the system selected and will be based on CBC 2001.

1.2.4 Wind Design

Basic Wind Speed	80 miles per hour
Exposure	Exposure B
Importance Factor	I= 1.0



1.3 Vibration Criteria

The maximum vibration velocity measured on the floor slab shall be as shown in the diagram to the left, and as on the vibration criterion diagram shown in Section 3.6-Space Types. The maximum vibration shall be calculated under moderate pace walking excitation. Less restrictive vibration criterion is proposed for non-sensitive areas such as faculty and student offices and classrooms/lecture hall areas. The ground floor shall be designed to meet the most restrictive vibration criterion. Except for the photo lithography area (approximately 450 sq.ft.), which shall be designed for a maximum vibration velocity of 250 micro-inch per sec., the rest of the ground floor would need to be designed for a maximum vibration velocity of 500 micro-inch per second measured on the floor under moderated walking pace.

3.0 Materials

3.1 Concrete

f'_c = 4000 psi Slab-on-grade
f'_c = 3000 psi Foundations and Piles
f'_c = 4000 psi Suspended floor slabs and beams
f'_c = 4000 psi Columns (non-seismic)
f'_c = 5000 psi Shear walls,

3.2 Reinforcing Steel

ASTM A615, Grade 60 -
ASTM A706 in boundary elements of shear walls

3.3 Structural Steel

ASTM 992 for all structural shapes except as noted otherwise
ASTM A500, Grade B for all structural tubes
A490 Anchor bolts
A325 High strength bolts, except as noted otherwise

4.0 Structural Building Description

4.1 General

The Material Science and Engineering Building is proposed as a 4-story lab building with a 3-story classroom/lecture component. The building is proposed as an L-shaped building with the smaller of the two wings dedicated to lecture hall and classrooms. The labs at the upper floor levels are located along the perimeter of the building. The total building area is approximately 134,000 gsf. For planning purposes, a 15'-6" floor-to-floor height is assumed at typical floor level and a 20'-0" at the ground floor level. A laboratory module of 11'-0" by 30'-0" clear has been proposed.

4.2 Geotechnical and Geological Condition

A preliminary geotechnical feasibility investigation report prepared by CHJ, Incorporated dated January 27, 2003 was made available for review for this programming phase. The site proposed for this project is the northwest corner of Aberdeen Drive and North Campus way. The site is fairly flat and is believed to be located within the natural channel of University Arroyo. Based on the limited boring performed by CHJ, Inc. it appears that the site is contains approximately 4 to 8 feet of fill and is underlain with loose unconsolidated young alluvial soils. The loose alluvium and undocumented soils generally blanket the site to depths of between 32 to 50 feet.

Based on their preliminary geotechnical investigation, it is CHJ's opinion that the foundation of the building would need to be deep foundations and the lowest level slab would need to be a structural slab (as opposed to typical 5-inch slab-on-grade). Alternately, a mat foundation may also be a viable option and should be explored during the design phase. The preliminary geotechnical opinions should be confirmed through more elaborate geotechnical investigation during the design phase once the exact location and size and structural system is firmed up.

The proposed site is not within a zone of active faulting.

4.3 Seismic Design

Seismic design criteria will be based on the latest edition of the California Building Code (CBC 1998) and the University of California Seismic Policy, which requires that the building attain a seismic rating of "good." We have assumed that special seismic performance goals are not required for this project, and the basic seismic design criteria contained in the 1997 *Uniform Building Code* will guide the design of the seismic system. Accordingly, we did not explore the feasibility of structural seismic system having higher seismic performance characteristics, such as seismic isolation and energy dissipation, since those would require an increase in the project construction budget because of their higher initial construction cost.

4.4 Structural Systems

4.4.1 Introduction

The Material Science and Engineering Building is planned as a Type I structure, and as such, both concrete and structural steel framing systems can be considered as viable alternatives. Each scheme offers advantages and disadvantages, however, it is anticipated that the building will be of concrete construction because of the strict vibration design requirements and because of users favorable experience with other concrete laboratory buildings with similar vibration requirements on the campus.

Concrete systems will have generally better vibration resistance than steel structures because of their increased mass and stiffness. It is more difficult to design a cost-effective steel structural system to meet the vibration criterion of 1,000 and 2,000 micro-inch per second especially with 30 feet plus clear span between columns. However, concrete structures are generally heavier than steel structures, and result in larger foundations and increased seismic demands. Typically, the structural frame of concrete structures is constructed more slowly than a steel structure. On the positive side, unlike steel construction, concrete framing does not need to be fireproofed.

The following section discusses the various viable concrete structural systems for the Materials Science and Engineering laboratory Building.

4.4.2 Cast-In-Place Concrete

<u>Gravity System</u>

Within the cast-in-place reinforced concrete systems, several alternate gravity structural systems are viable for this building. This includes two-way slab system, flat plate system, and one-way slab and beam system. All of these three systems can be made to work with the proposed functional and architectural requirements and the vibration criterion of 1,000 to 2,000 micro-inches per second. However, if the proposed laboratory spaces are to be kept column free (i.e., no column can be placed within the lab space which spans 30 plus feet clear) then one-way slab system, at least in the laboratory area, would most likely yield the most cost-effective design. The one-way slab system would yield the least heavy of all the concrete schemes. With seismic design forces being directly proportional to the building mass, a reduction in mass while still meeting the vibration criterion is desirable since it reduces the cost of the seismic bracing system as well as the cost of the foundation.

Alternately a flat plate scheme may also be explored although the thickness of the slab required for the 1,000 to 2,000 micro-inch per second is likely to be substantial unless the column spacing can be reduced in the proposed laboratory spaces (i.e., columns spaced less than 30 feet apart). This may result in a significantly heavier building, which in turn will penalize the seismic design and the foundation design thus significantly adding to the construction cost. The slab thickness may be reduced by spacing the columns closer but that may not be very desirable especially in the lab spaces.

Seismic Bracing System
With regards to the seismic bracing system, either a concrete shear walls or a concrete moment frame scheme can be used. A concrete shear wall scheme will be significantly less expensive but may limit the architectural and functional layout flexibility. This concern can be mitigated somewhat by locating the shear walls around stairwells, or elevator shafts and/or around the perimeter of the building.

Alternatively, concrete ductile frames could also be used to resist seismic loads. The columns and beams would be substantially larger than those needed for gravity loads, with the columns approaching 30-inches in plan dimension and girders up to 30- to 36 inches in depth. The size of these members may make it difficult to provide mechanical services to some areas of the building without increasing the floor-to-floor height. Also the concrete frame system will be significantly more expensive than the concrete shear wall system.

4.4.3 Steel System
As stated earlier, a steel structural system is not believed to be a viable structural system because of the difficulty in meeting the strict vibration requirements with the 30 feet plus beam span. However, steel scheme may represent an alternative system that might become more desirable if vibration criteria could be relaxed. Vibration problems are more frequent in steel structures because of their lighter mass and lower stiffness. A steel structural scheme offers the advantage of being significantly lighter than the concrete schemes that would result in smaller foundations and decreased seismic demands. Typically, the frame of steel structures is constructed more quickly than a concrete structure, although there is substantial lead-time on steel mill orders and the steel framing needs to be fireproofed.

For the steel scheme, the seismic bracing system would typically be provided by steel brace frames or steel moment frames. Steel brace frames are generally significantly less expensive than the steel moment frames.

Recommendation
Based on our understanding of the project needs, a concrete building with shear wall for the seismic bracing system and concrete one-way slab with beams and girders appears to be the most viable structural system for the proposed Materials Science and Engineering Building. Accordingly, it is the basis for the cost estimate contained in the DPP. The concrete shear wall should be located where it least impacts the architectural and functional space layout but at the same time works effectively.

The foundation system for the building will most likely consists of deep foundation (drilled piers), which will probably extend up to 60 to 70 feet. Because of the presence of collapsible soil and the need to maintain a very stiff lowest level slab for vibration consideration, it is anticipated that the traditional slab-on-grade would not be viable on this project. Settlement of the soil due to loading conditions, changes in moisture content, and seismic events may result in loss of bearing support for the lowest level slab. Accordingly, the lowest level slab may need to be designed as a structural slab and may not rely on soil for the support (per the soils engineer). As such it is anticipated that a structural slab (flat slab) of approximately 15 to 18 inches thick or additional piles at mid-span of the slabs may be required to provide a stiff slab that meets the very restrictive vibration criterion of 500 micro-inch/sec.

6.7 Building Materials

A preliminary list and matrix of materials and finishes are delineated below both as a programmed basis of design and for a projected estimate of cost. All assumptions of materials and finishes are based on current expectations of cost, performance, and aesthetics; and as such these will need to be reexamined during the design phases.

Exterior

- Brick – Norman – UCR Blend
- Aluminum and Glass curtain wall – low e clear glazing and spandrel glass.
- Architectural cast stone – string courses and miscellaneous trim.
- Zinc covered copper – sloped roof, roof trim and screens.
- Membrane roof – miscellaneous flat roof areas.

Interior

Room Type	*Floor*	*Base*	*Wall*	*Ceiling*
Laboratory Lab Support	VCT or Sheet Vinyl	Vinyl or Self-coving	Paint Gypsum Wallboard	ACT with painted GWB trim
Offices Administration Support Conference	Carpet	Wood or Vinyl	Painted GWB	ACT with painted GWB trim
General Assignment Classrooms	Carpet	Wood	Painted GWB w/ acoustic treatment hardwood trim	Painted GWB w/ acoustical treatment or ACT trim

6.8 Applicable Codes and Regulations

The following Codes and Standards are provided for general reference as the basis for the DPP document. At the time of design, the most recently adopted versions of all applicable codes as well as the then-current University standards will need to be utilized as the basis for design. The design team will need to make the final determination as to the relevance and application of these codes as well as others that may apply but not be included in the list below.

BUILDING CODES

- California Building Standards Code, Title 24 of the California Code of Regulations. 2001 Edition
- Uniform Building Code, 1997 edition, and 2001 California Amendments
- Uniform Building Code Standards, 1997 edition
- Uniform Mechanical Code, 1997 edition, and 2001 California Amendments
- Uniform Plumbing Code, 1997 edition, and 2001 California Amendments
- Uniform Fire Code, 2000 edition
- National Electric Code, 2001 edition, and 1998 California Amendments
- California Code of Regulations, California Administrative Code Title 24, 1998 edition
- California Code of Regulations, Title 21 - Public Works
- California Health and Safety Code, current regulations
- State of California Fire Code, 2001 Edition
- NFPA 10, National Fire Protection Association Standard for Portable Fire Extinguishers, 2000 edition
- NFPA 13, National Fire Protection Association Installation of Sprinkler Systems, 2000 edition
- NFPA 14, National Fire Protection Association Installation of Standpipe and Hose systems, 2000 edition
- NFPA 24, National Fire Protection Association Installation of Private Fire Service Mains and Their Apparatus, 1995 edition
- NFPA 30, National Fire Protection Association Flammable and Combustible Liquids Code, 2000 edition
- NFPA 45, National Fire Protection Association Standard on Fire Protection for Laboratories Using Chemicals, 2000 edition
- NFPA 72, National Fire Protection Association National Fire Alarm Code, 1993 edition
- NFPA 101, National Fire Protection Association Code for Safety to Life from Fire in Buildings and Structures, 2000 edition

REFERENCE STANDARDS AND REGULATIONS

- University of California, Riverside Campus Standards and Design Criteria.
- Americans with Disabilities Act (ADA), 1991, Title 3 and ADA P.L. 101-336
- Federal Standard 29 CFR Part 1910.1450 Occupational exposures to hazardous chemicals in laboratories
- American National Standards Institute 2358.1: Emergency Eyewash and Shower Equipment, 1990
- American National Standards Institute/American Industrial Hygienists Association 29.5 Standard for Laboratory Ventilation, 1992
- National Institutes of Health NIH 76-900 Safety Standards for Research Involving Chemical Carcinogens, Office of Research Safety
- National Institutes of Health NIH 93-8395 Guidelines for the Laboratory Use of Chemical Carcinogens, 1981
- Cast Iron Soil Pipe Institute (CISPI)
- Manufacturers Standardization Society (MSS)
- National Bureau of Standards
- Plumbing & Drainage Institute (PDI)
- South Coast Air Quality Management District (SCAQMD)
- Underwriters Laboratory (U.L.)
- Illuminating Engineering Society of North America (IES)
- Sheet Metal and Air Conditioning Contractors National Affiliation (SMACMA)
- Institute of Electrical & Electronics Engineers (IEEE)
- National Electrical Manufacturers Affiliation (NEMA)
- Occupational Safety and Health Administration (OSHA)
- American National Standards Institute (ANSI)
- American Society of Testing Materials (ASTM)
- American Welding Society Code (AWSC)
- American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
- Standard 62
- Standard 90 A, B, C Energy Conservation in New Building Design
- Standard 100 Energy Conservation in Existing Buildings
- ASHRAE Fundamentals
- ASHRAE Systems and Applications
- ASHRAE Equipment

All of the above codes, standards and requirements should be reviewed as to the currently adopted version at the time of the design.

OCCUPANCY DESIGNATION

The occupancy group designation within the California Building Code, 2001 Edition for laboratory buildings is governed by the type, quantity and storage methods for hazardous materials and chemicals used for research within the building. Common occupancy designations for laboratory buildings include "B" and "H-8". The program for the building includes offices, research laboratories (wet and dry), teaching laboratories and university classrooms. The University General Assignment Classrooms would fall within the assembly occupancy classification Group "A" which is defined as; "Any building or portion of a building having an assembly room with an occupant load of less than 300 or more than 300 without a legitimate stage, including such buildings used for educational purposes and not classified as a group E or Group B Occupancy". Each of these designations presents implications regarding specific standards for construction materials, allowable floor area, building height, fire-ratings for construction separations between spaces, the protection of penetrations between spaces and exiting requirements.

During the DPP process, different occupancies were evaluated. It was determined that the optimal occupancy for the Materials Science and Engineering Building, excluding the classrooms is "H-8". The clean room could be "H-7". It was determined that H-6 occupancy for the clean room would not be feasible. A hazardous material inventory would be required during the design phase in order to confirm this occupancy designation assumption. See H Occupancy comparison tables at the end of this section.

B-2 OCCUPANCY SUMMARY

There are limits on quantities of hazardous materials, which can be used and stored in laboratories under B-2 occupancy classification. These limits are described in Tables 3-I and 3-E of the California Building Code (CBC) as "Exempt Amounts of Hazardous Materials Presenting a Physical [or Health] Hazard, Maximum Quantities per Control Area". The Department understands these limitations and will manage the chemical inventory as required to stay within the guidelines.

The amounts shown are the maximum allowed per laboratory control area. Control areas are limited to 10,000 square feet in size and must be separated by a one-hour fire resistive occupancy separation. In Type I buildings, which do not exceed three (3) stories in height, the two-hour floor separation is often a convenient way of separating control areas.

Fire Sprinklers: 100% Sprinklered Building, Ordinary Hazard

Fire Fighting Access: The University will coordinate with the City of Riverside Fire Department to provide suitable access for fire fighting. The Executive Architect will need to work closely with the Campus Fire Marshal to confirm access requirements for this building. This access will need to be integrated with access requirement for adjacent structures.

The current interpretation of "B-2" is to require individual ductwork from each fume hood and not have the ductwork manifolded which is more costly.

H-8 LABORATORY OCCUPANCY SUMMARY

An "H-8" occupancy is required by the University for lab uses. This occupancy (in the California Building Standards Code, 2001 Edition) is intended for laboratories and similar areas used for scientific experimentation or research having quantities of materials not in excess of those listed in CBC Table 3-D.1 and 3-I and not otherwise classified as Group B occupancies. Maximum suite size must be 10,000 square feet.

For the purposes of the DPP, it is assumed that the exempt material storage amounts will not be exceeded, based upon current University experience. However, a chemical inventory for the proposed laboratories should be compiled as early as possible in the schematic design phase of this project so that it can be confirmed whether the needs of those laboratories will be able to be met.
The design team must utilize and apply the current code and code interpretations in force at the time of the design. For purposes of the DPP the following summary of the Group "H-8" major requirements are being considered:

1. Occupant load factor: 100 square feet/occupant (Table 10A)
2. Laboratory suite: 10,000-sf maximum, no limit on number of suites in building (Table 3-D, 1, 3-1)
3. Continuous 1-hour occupancy separation between lab suites of up to 10,000 sq. ft. each. (307.2.12)
4. Labs, shops and similar areas shall not require an occupancy separation when the use of the area is determined to be compatible. Classrooms and offices directly related to the use shall not require an occupancy separation. (307.2.12)
5. One-hour separation between fume hood exhaust ducts and fire-resistive exit corridors (307.2.13)
6. One-hour separation between lab interstitial space and corridor (307.2.13)
7. 1-hour rated slab-to-slab or tunnel, rated floor/ceiling assembly. Three-quarter hour rated corridor doors with smoke gasketing (1007.4.3)
8. Each portion of floor area 200 square feet or more requires two exits (1007.4.1)
9. Each portion of the floor area must be within 75 feet of an exit door (1007.4.2)
10. For buildings of four floors or more, each floor requires two-hour fire resistive horizontal exit. Each side of horizontal exit shall be provided with separate mechanical exhaust system, without interconnection. No side less than 30% of total floor area. At least one elevator required to serve each side of horizontal exit (1007.4.7).
11. Rooms with cumulative occupant load of 10 or less may exit through more than one intervening room (1003.5)
12. Fire dampers prohibited in fume hood exhaust ducts (307.5.5)

13. Floor penetrations to maintain fire-resistive and liquid tight characteristics of 4 inches above floor (307.2.13)
14. Emergency power to supply all required electrical equipment when normal supply is interrupted (307.2.8)
15. Exhaust from each unit ducted separately to outside the building, mechanical space or shaft (307.5.5)
16. Spill emergency-response equipment room on each floor (307.2.12)
17. Ducts conveying explosives or flammable vapors, fumes, or dust shall extend directly to the exterior of the building without entering other spaces. Exhaust ducts shall not extend into or through ducts or plenums (1202.2.3). The exception to this is "ducts conveying vapor or fumes have flammable constituents less than 25% of their lower flammable limit."
18. Ventilation manual emergency shut-off located outside the room adjacent to principle access door. (1202.2.3)
19. Hazardous Material Management Plan (HMMP) required (307.1.6)
20. Spill control: Liquid tight floor and sill; 20 minute sprinkler drainage; secondary containment for spills and fire protection water (307.2.3)
21. Panic hardware required for latching or locking doors (1018)
22. Automatic or self-closing doors required (1018)
23. Automatic sprinkler system required, minimum Ordinary Hazard Group 3 over 3,000 square feet (904.2.6.4)
24. Class I standpipe is required for occupancies four stories or more, but less than 150 feet in height (Table 9-A)

Major Differences - H8 vs. H6 Occupancies		
Conditions	**H8 Occupancies**	**H6 Occupancies**
1. Hazardous Materials Amounts	♦ **Exempt Amount Increases:** ▪ Fire Sprinkler System Increase: No ▪ Storage Cabinet Increase: Yes ♦ **Health Hazard Materials:** Limited to CBC Table 3-I Exempt Amounts which are less than both B/S1 Occupancy conditions & H7 Occupancy allowable amounts. ♦ **Physical Hazard Materials:** Limited to CBC Table 3-D.1 Exempt Amounts which are less than B/S1 Occupancy & H7 Occupancy Exempt Amounts.	♦ **Exempt Amount Increases:** ▪ Fire Sprinkler System Increase: Yes ▪ Storage Cabinet Increase: Yes ♦ **Health Hazard Materials:** Not limited. ♦ **Physical Hazard Materials:** CFC Tables 5102-A, 5102-B quantity limits.
2. Control Areas – Hazardous Materials	♦ Not applicable to H-8. ♦ Each "laboratory unit" limited to 10,000 sf. ♦ Hazardous materials in each "laboratory unit" limited to CBC Tables 3-D.1 & 3-I Exempt amounts. ♦ Laboratory units separated from each other by 1-hour fire-resistive occupancy separation. ♦ No specific limit on number of "laboratory units" in a building.	♦ Not applicable to H6 Occupancies. ♦ Up to Exempt Amounts allowed, with increases limited based on area [sf] of the H6 area. ♦ Storage >Exempt Amounts required in H2, H3, H7 Occupancy storage/HPM rooms.
3. Building Area – Fire Sprinkler System Increase	Does not appear to be allowed.	Allowed.
4. Lab Areas [sf]	Each "laboratory unit" limited to 10,000 sf.	Not limited.
5. Spill Control & Containment	Not required.	Spill control required for each tool/ workstation.
6. Exhaust Ventilation Systems	♦ **Duct Construction:** Noncombustible. ♦ **Type of System:** Local – through hoods. ♦ **Treatment System:** Not specifically required.	♦ **Duct Construction:** Dependent on products conveyed. ♦ **Type of System:** General area @ >/=4 cfm per sf of floor area and local for tools & workstations. ♦ **Treatment System:** May be required for Flammable Gases, Highly Toxic Gases, Highly Toxic Liquids, Pyrophoric Gases, Toxic Gases.
7. Alarm & Detection Systems	None appear to be required.	The following alarm/detection systems may be required, depending on the hazardous materials & material conditions involved: ♦ Emergency Alarm System ♦ Fire Alarm System ♦ Gas Detection System ♦ Limit Controls
8. Chemical Delivery to/from H6 Areas	No restrictions/limitations.	HPM chemicals can only be delivered to/ from H6 areas by/through the following methods: ♦ Through a service corridor, with chemical delivery to the service corridor from outside the building or H Occupancy chemical storage/HPM room. ♦ Directly from H Occupancy chemical storage/HPM room directly to the H6 area. ♦ Directly from outside the building to the H6 area.
9. Service Corridors for Chemical Delivery	Not required.	♦ See Item 8. Service corridors for delivery of chemicals to/from H6 areas may be required. ♦ Service corridors cannot be used as part of the exit system for H6 or other occupancies.
10. Location in Building	3rd floor or below.	♦ Floors 1-3 only. ♦ Portion of building containing H6 cannot be more than 3 stories.

Major Differences - H8 vs. H7 Occupancies		
Conditions	**H8 Occupancies**	**H7 Occupancies**
1. Hazardous Materials Amounts	♦ **Exempt Amount Increases:** ▪ Fire Sprinkler System Increase: No ▪ Storage Cabinet Increase: Yes ♦ **Health Hazard Materials:** Limited to CBC Table 3-I Exempt Amounts which are less than both B/S1 Occupancy conditions & H7 Occupancy allowable amounts. ♦ **Physical Hazard Materials:** Limited to CBC Table 3-D.1 Exempt Amounts which are less than B/S1 Occupancy & H7 Occupancy Exempt Amounts.	♦ **Exempt Amount Increases:** ▪ Fire Sprinkler System Increase: Yes ▪ Storage Cabinet Increase: Yes ♦ **Health Hazard Materials:** Not limited. ♦ **Physical Hazard Materials:** Limited to CBC Table 3-D/CFC Tables 7902.5-A, 7903.3-A, 8001.15-A Exempt Amounts,
2. Control Areas – Hazardous Materials	♦ Not applicable to H-8. ♦ Each "laboratory unit" limited to 10,000 sf. ♦ Hazardous materials in each "laboratory unit" limited to CBC Tables 3-D.1 & 3-I Exempt amounts. ♦ Laboratory units separated from each other by 1-hour fire-resistive occupancy separation. ♦ No specific limit on number of "laboratory units" in a building.	♦ Four [4] per building. ♦ Applies only to physical hazard materials as health hazard materials are allowed in unlimited quantities. ♦ Physical hazard materials in each Control Area limited to CBC Tables 3-D & 3-E and CFC Tables 7902.5-A, 7903.3-A, 8001.15-A Exempt Amounts. ♦ Control Areas separated from each other by 1-hour fire-resistive occupancy separation.
3. Building Area – Fire Sprinkler System Increase	Does not appear to be allowed.	Allowed.
4. Lab Areas [sf]	Each "laboratory unit" limited to 10,000 sf.	Not limited.
5. Spill Control & Containment	Not required.	Required for certain conditions.
6. Exhaust Ventilation Systems	♦ **Duct Construction:** Noncombustible. ♦ **Type of System:** Local – through hoods. ♦ **Treatment System:** Not specifically required.	♦ **Duct Construction:** Dependent on products conveyed. ♦ **Type of System:** General area @ >/=1 cfm per sf of floor area and local through hoods as applicable. ♦ **Treatment System:** May be required for Highly Toxic Gases, Highly Toxic Liquids, Toxic Gases.
7. Alarm & Detection Systems	None appear to be required.	The following alarm/detection systems may be required, depending on the hazardous materials & material conditions involved: ♦ Emergency Alarm System ♦ Gas Detection System ♦ Limit Controls

NFPA 30: FLAMMABLE AND COMBUSTIBLE LIQUIDS CODE

Liquid Classification: Combustible liquids have a flash point at or above 100° (37.8°C) and are classified as follows:

i. Class II: Liquids with a flash point at or above 100°F (37.8°C) and below 140°F (60°C)
ii. Class III A: Liquids with a flash point at or above 140°F (60°C) and below 200°F (93°C)
iii. Class III B: Liquids with a flash point at or above 200°F (93°C)

Flammable liquids have a flash point below 100°F (37.8°C) and a vapor pressure not greater than 40 pounds per square inch (absolute) (2,068 mm Hg) at 100°F (37.8C). Flammable liquids are classified as follows:

i. Class I A: Liquids with flash point below 73°F (22.8C) and a boiling point below 100°F (37.8°C)
ii. Class I B: Liquids with flash point below 73°F (22.8°C) and a boiling point at or above 100°F (37.8°C)
iii. Class I C: Liquids with flash points at or above 73°F (22.8°C) and below 100°F (37.8°C)

Storage Cabinets:
Not more than 120 gallons (454 L) of Class I, Class II, and Class III, a liquid may be stored in a storage cabinet. Of this total, not more than 60 gallons (227 L) may be of Class I and Class II liquids and not more than three (3) such cabinets may be located in a single Fire Area, except that, in an industrial occupancy, additional cabinets may be located in the same Fire Area if the additional cabinets (not more than a group of three (3) are separated from other cabinets or group of cabinets by at least 100 feet (30m).

In addition to the above standards it will be necessary during the design phases of the project to work closely with the representatives. The project team may need to incorporate additional requirements as laboratory and support spaces are more definitively outlined.

NFPA 45: FIRE PROTECTION FOR LABORATORIES USING CHEMICALS

Means of Egress: The means of egress for laboratory units and laboratory work areas shall comply with NFPA 101.

Access to Exits: A second means of access to an exit shall be provided from a laboratory work area if any of the following situations exist:

i. A laboratory work area contains an explosion hazard so located that an incident would block escape from or access to the laboratory work area.

ii. A fume hood in a laboratory work area is located adjacent to the primary means of exit access.
iii. A compressed gas cylinder in use which is larger than lecture bottle size, and contains a gas which is flammable or has a hazard rating of 3 or 4 and would prevent safe egress in event of accidental release of cylinder contents.
iv. The required exit doors of all laboratory work areas within Class A or Class B laboratory units shall swing in the direction of exit travel.

Furniture and Equipment: Furniture and equipment in laboratory work areas will be arranged so that means of access to an exit may be reached easily from any point.

Explosion Hazard:
Explosion hazard is considered to exist if materials with a reactivity rating of 4 are stored or used, or if highly exothermic reactions or procedures without established properties are planned, or if high pressure reactions are planned.

Program information does not indicate that explosion hazards, as described above, exist in this project.

NFPA 101: LIFE SAFETY CODE

Means of Egress:
Where exits are not immediately accessible from an open floor area, safe and continuous passageways, aisles, or corridors will be maintained leading directly to every exit and will be arranged as to provide convenient access for each occupant to at least two exists by separate ways of travel.

Exit access will be so arranged that it will not be necessary to pass through any area identified under protection from hazards in Chapter 28.

Corridor Width: The minimum width of any corridor or passageway serving as a required exit, exit access, or exit discharge will be 44 inches.

CONSTRUCTION TYPE

The following tables present the maximum allowable height and floor areas for the Materials Science & Engineering Building for each allowable California Building Code construction types & occupancies. Table 6-A of the California Building Code provides additional information regarding the specific fire resistive requirements of building components for each construction type. The maximum allowable area for this site assumes increases in basic allowable area for multi-story buildings, 100% increase for a fully sprinkled building (except “H-8” area since sprinklers are mandated by code for “H-8” occupancy per the Fire Marshal), and a 100% increase for due to side yard separations.

Based on California Building Code Chapter 5 and Table 5-B

B or H-8 Occupancy

Construction Type	Allowable Height	Basic Allowable Area	Maximum Allowable Area
I	Unlimited	Unlimited	Unlimited
II FR	160 ft, 12 stories	39,900	159,600 (1)
II One Hour	65 ft, 4 stories (2)	18,000	144,000 (1) (3)

(1) Includes allowable increase for multiple floor (x2), sprinkled (x2)
(2) Design exceeds allowable height
(3) Includes allowable increase for 40 ft. sideyards (x2)

A Occupancy

Construction Type	Allowable Height	Basic Allowable Area
I	Unlimited	Unlimited
II FR	160 ft, 4 stories	299,000
II One Hour	65 ft, 2 stories	13,500

Allowable Area Tables
The assumption for the purposes of this DPP is that the Materials Science and Engineering Building is of Type I construction.

When a building houses more than one occupancy, the area of the building shall be such that the sum of the ratios of the actual area for each separate occupancy divided by the total allowable area for each separate occupancy shall not exceed one.

HIGH RISE REQUIREMENTS

Group B occupancies having floors used for human occupancy more than 75 feet above the lowest level of the fire department vehicle access are classified as high-rise buildings. High-rise buildings are required to be Type I or Type II-FR construction, to have automatic sprinkler protection and required to meet all the requirements of California Building Code Section 403. These requirements include smoke detection, smoke control, pressurized exit stairs with vestibules, fire alarm and communication system, a central control station for fire department operations, elevator lobbies, and stand-by-power, light and emergency systems.

For the purpose of this DPP it is assumed that the Materials Science & Engineering Building is <u>not</u> of high rise construction.

CAMPUS REQUIREMENTS

The project will be subject to campus requirements, including:

- UCR Campus Standards and Design Criteria
- Environmental, Health and Safety Regulatories
- Environmental Impact Report (EIR)
- Seismic policy

REVIEWING AUTHORITIES

UCR Capital Planning staff will review the final project planning documents. The UCR Design & Construction serves as the local Building Official. In addition to the Building Official, design and construction documents will also be reviewed, approved, and stamped by the Division of the State Architect (DSA) for accessibility compliance, and the state Fire Marshal (SFM), for Fire/Life Safety compliance. Documents may be reviewed with various campus agencies for compliance with the campus requirements.

Budget & Schedule

Project Budget

7.1 Basis of Cost Plan

The University of California, Riverside has a total project budget for Materials Science and Engineering Building of $55,969,000 including movable equipment. This budget is based on the California Construction Cost Index No.CCC14019. The total project costs include soft costs and project funded escalation. The Construction Cost Plan for MS&E totals $40,006,000 for both building and site costs. This plan does not factor escalation or soft costs for the project into the constructions costs. Additional detail on the Construction Cost Plan is available in Appendix I, A3.0.

The pricing is based on the following general conditions of construction:

- A start date of January 2006
- The general contract will be competitively bid with qualified general and main subcontractors
- There will not be small business set aside requirements.
- The contractor will be required to pay prevailing wages.
- There are no phasing requirements.
- The general contractor will have full access to the site at regular construction hours.

7.2 Inclusions

The project consists of a new 4-story laboratory building with a 3-story classroom/lecture hall component of approximately 134,000 gross square feet Marterials Science and Engineering building together with associated site work covering an approximate area of 148,000 gross square feet. The program areas includes instructional and research wet and dry laboratories and support space, a clean room core, faculty and student offices and general administrative support functions and general assignment classrooms.

7.3 Exclusions

- Design, testing, inspection or construction management fees
- Architectural and design fees
- Scope change and post-contract contingencies
- Assessments, taxes, finance, legal and development charges
- Environmental impact mitigation
- Builder’s risk, project wrap-up, and other owner provided insurance programs
- Land and easement acquisition

- Cost escalation beyond a construction mid point of January 2007
- Owner supplied and installed furniture, fixtures, and equipment
- Loose furniture and equipment except as specifically identified
- Seating to small and medium classrooms
- Security CCTV surveillance cameras and monitors
- Audio visual equipment and cabling
- Atrium smoke management systems
- Hazardous material handling, disposal and abatement
- Compression of schedule, premium or shift work, and restrictions on the contractor's working hours.
- Owner provided Uninterrupted Power Source (UPS)
- Atrium smoke management systems
- Clean room H-6 occupancy
- Clean room tool hook ups (specialty piping, exhaust, cooling water, electrical, etc.)
- Exhaust scrubbers
- Owner sponsored mechanical and electrical commissioning

7.4 Overall Summary

	Gross Floor Area	$ / SF	$x1,000
Building	134,000 SF	283.48	37,986
Sitework	148,000 SF	13.64	2,020
TOTAL Building & Sitework Construction	April 2003		40,006
Owner sponsored mechanical and electrical commissioning			250
Building electronics (telecom hubs and routers)			160

Please refer to the Inclusions and Exclusions sections of this report

7.5 Building Component Summary

BUILDING COMPONENT SUMMARY

	Gross Area:	**134,000 SF**	
		$/SF	$x1,000
1. Foundations		8.01	1,074
2. Vertical Structure		10.26	1,375
3. Floor & Roof Structures		26.58	3,562
4. Exterior Cladding		26.33	3,528
5. Roofing & Waterproofing		2.53	340
Shell (1-5)		73.72	9,878
6. Interior Partitions, Doors & Glazing		14.16	1,897
7. Floor, Wall & Ceiling Finishes		9.12	1,222
Interiors (6-7)		23.28	3,119
8. Function Equipment & Specialties		20.87	2,796
9. Stairs & Vertical Transportation		4.51	605
Equipment & Vertical Transportation (8-9)		25.38	3,401
10. Plumbing Systems		18.33	2,456
11. Heating, Ventilating & Air Conditioning		51.55	6,907
12. Electric Lighting, Power & Communications		34.03	4,560
13. Fire Protection Systems		3.16	424
Mechanical & Electrical (10-13)		107.07	14,347
Total Building Construction (1-13)		**229.44**	**30,745**
14. Site Preparation & Demolition		0.00	0
15. Site Paving, Structures & Landscaping		0.00	0
16. Utilities on Site		0.00	0
Total Site Construction (14-16)		**0.00**	**0**
TOTAL BUILDING & SITE (1-16)		**229.44**	**30,745**
General Conditions	8.00%	18.36	2,460
Contractor's Overhead & Profit or Fee	4.00%	9.91	1,328
PLANNED CONSTRUCTION COST	***April 2003***	**257.71**	**34,533**
Contingency for Design Development	10.00%	25.77	3,453
Allowance for Rising Costs @ 3.0% PA	12.00%	34.01	4,558
RECOMMENDED BUDGET	***January 2007***	**317.49**	**42,544**

7.6 Sitework Component Summary

SITEWORK COMPONENT SUMMARY

	Gross Area:	**148,000 SF**	
		$/SF	$x1,000
1. Foundations		0.00	0
2. Vertical Structure		0.00	0
3. Floor & Roof Structures		0.00	0
4. Exterior Cladding		0.00	0
5. Roofing & Waterproofing		0.00	0
Shell (1-5)		0.00	0
6. Interior Partitions, Doors & Glazing		0.00	0
7. Floor, Wall & Ceiling Finishes		0.00	0
Interiors (6-7)		0.00	0
8. Function Equipment & Specialties		0.00	0
9. Stairs & Vertical Transportation		0.00	0
Equipment & Vertical Transportation (8-9)		0.00	0
10. Plumbing Systems		0.00	0
11. Heating, Ventilating & Air Conditioning		0.00	0
12. Electric Lighting, Power & Communications		0.00	0
13. Fire Protection Systems		0.00	0
Mechanical & Electrical (10-13)		0.00	0
Total Building Construction (1-13)		**0.00**	**0**
14. Site Preparation & Demolition		1.25	186
15. Site Paving, Structures & Landscaping		7.66	1,133
16. Utilities on Site		2.13	315
Total Site Construction (14-16)		**11.04**	**1,634**
TOTAL BUILDING & SITE (1-16)		**11.04**	**1,634**
General Conditions	8.00%	0.89	131
Contractor's Overhead & Profit or Fee	4.00%	0.48	71
PLANNED CONSTRUCTION COST	***April 2003***	**12.40**	**1,836**
Contingency for Design Development	10.00%	1.24	184
Allowance for Rising Costs @ 3.0% PA	12.00%	1.64	242
RECOMMENDED BUDGET	***January 2007***	**15.28**	**2,262**

Budget & Schedule

8.0 Schedule

8.1 Schedule

Overview

The Project Schedule outlines the four phases for the Materials Science & Engineering project including the Detailed Project Program (DPP), Project Planning Guide (PPG), Design Phases, and Construction.

Issues to be addressed on the project that may affect the schedule include:

- Completion of site utilities to the site by the University.
- Completion of a geotechnical report and site survey.
- Comprehensive review of building code issues.

Detailed Project Program (DPP)

The purpose of the Detailed Project Program Phase is to prepare a program, concept, cost model, and schedule to aid in preparation of the Project Planning Guide. The DPP phase began in November 2002 with the selection of HGA/KMW as the programming and planning consultant. The final DPP completion date is March 31, 2003.

Project Planning Guide (PPG)

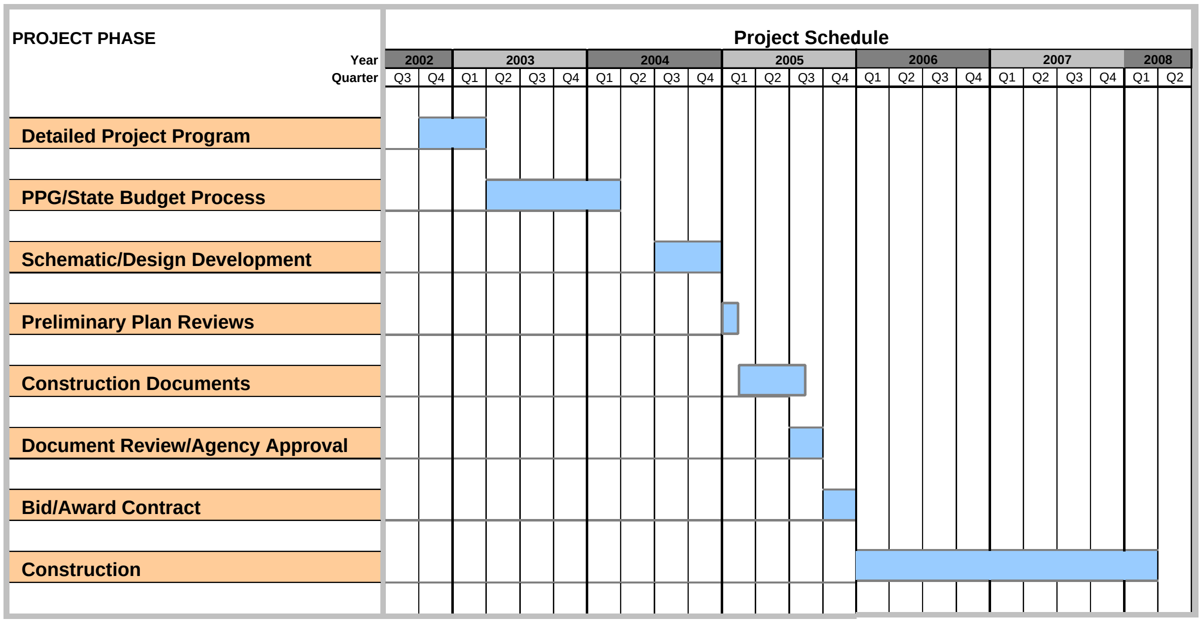
The purpose of the Project Planning Guide is to provide specific project justification to the Office of the President based on information provided in the DPP. The PPG phase will be complete by March 2004 for allocation of funds by July 2004.

Design Phases

Following approval of funding for design, the University of California Riverside will proceed with selection of an Architect. The design process will begin with schematic design and continue through design development and preparation of construction documents. This process is anticipated to take approximately 15 months and include agency reviews and final revisions to bid documents.

Construction

The Construction process will begin with competitive bidding, followed by award of the construction contract and construction. Construction is anticipated to take approximately 27 months including award of the construction contract.


PROJECT PHASE
Project Schedule
Year
Quarter
2002
2003
2004
2005
2006
2007
2008
Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2
Detailed Project Program
PPG/State Budget Process
Schematic/Design Development
Preliminary Plan Reviews
Construction Documents
Document Review/Agency Approval
Bid/Award Contract
Construction