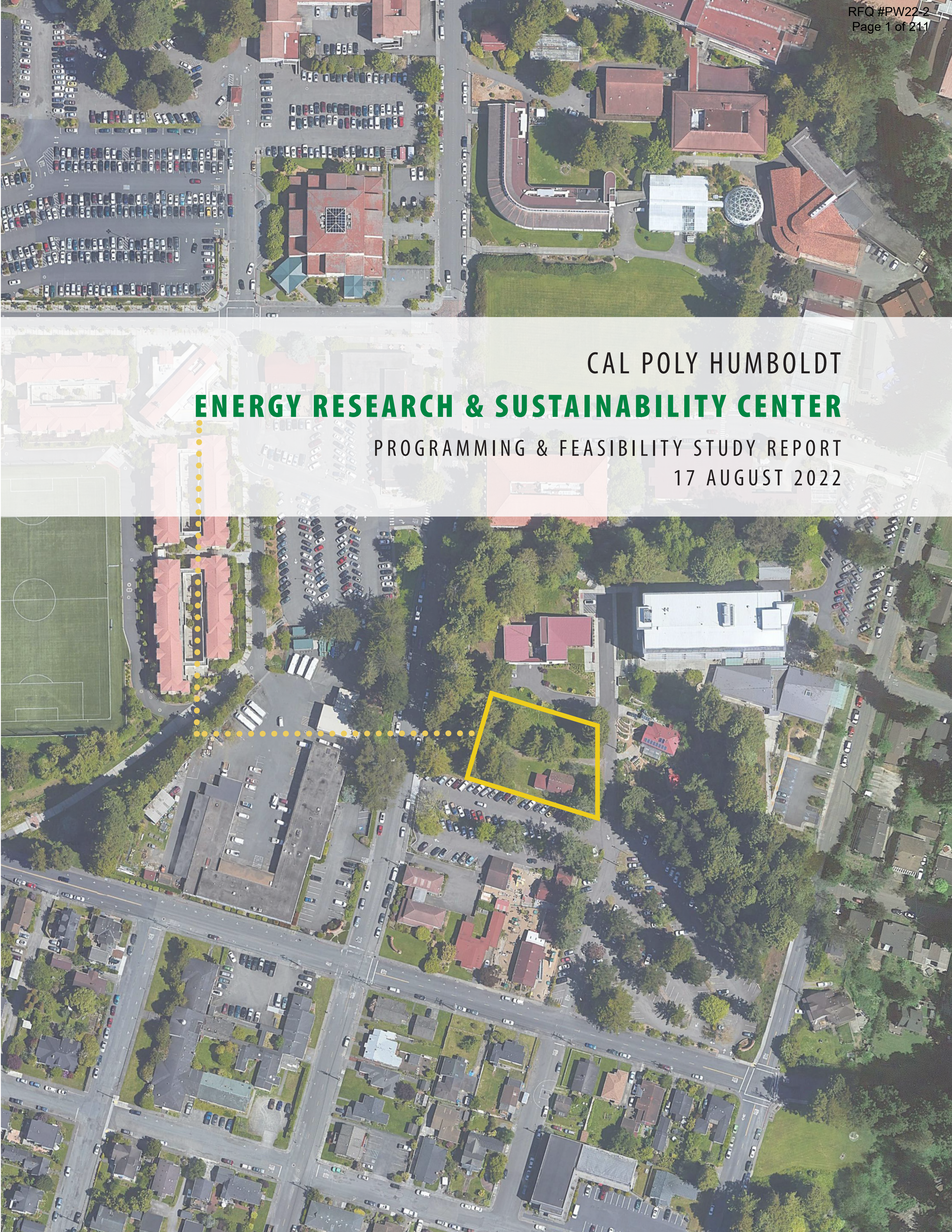

CAL POLY HUMBOLDT

ENERGY RESEARCH & SUSTAINABILITY CENTER

PROGRAMMING & FEASIBILITY STUDY REPORT

17 AUGUST 2022

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01
INTRODUCTION


Photo Credit: Courtesy of Cal Poly Humboldt

1.1 EXECUTIVE SUMMARY

This Feasibility Study was commissioned by Facilities Planning, Design and Construction at California State Polytechnic University, Humboldt (Cal Poly Humboldt) to develop the vision pillars, project goals, evaluation criteria, space program, adjacency priorities and conceptual test-fits, and basis of design criteria for the new Energy Research and Sustainability Center (ER+SC). The contents of this document also include baseline performance requirements to inform a Collaborative Design Build procurement.

OVERVIEW

With the State of California's historic $458 million investment in designating Cal Poly Humboldt as the third polytechnic institution within the California State University system, 27 new academic and experiential programs are expected to be added by 2029, beginning with 12 launching in 2023. This will be the catalyst for greater investments over the coming decade to fuel a vitally relevant polytechnic education in Northern California.

Beginning with a foundational core that combines the liberal arts with creative interdisciplinary approaches to solving real world problems facing our society, Cal Poly Humboldt will prepare a new generation of resilient thinkers and doers to lead a restorative future centered on environmental and social justice.

In this context, Cal Poly Humboldt has begun development of a renewable energy microgrid to support campus resilience through clean generation. This microgrid will be part of the campus' sustainability framework, and will enable students in engineering, environmental sciences, and other programs to gain hands-on experience with innovative climate-friendly technologies.

These efforts build on decades of work towards clean energy and sustainability on the Humboldt campus that have involved a range of entities and groups.

PROJECT SCOPE OVERVIEW

The project for the new Energy Research and Sustainability Center will provide a hub for interdisciplinarity and inclusive collaboration that supports climate action through energy systems research and teaching and justice driven sustainability initiatives. It is envisioned that the new build will also serve as a welcoming place for campus and community partnerships, education, sustainability resources, and convening space for innovation to develop collaborative partnerships for human centered climate action and resilient practices.

The ER+SC project will consist of new construction of (23,000 GSF) campus building supporting the new Energy Systems Engineering degree program and other campus academic programs related to clean energy, while also strategically collocating a new sustainability center. The new facility will also be supported by the Schatz Energy Research Center, academic program integration, and the Office of Sustainability.

Land Acknowledgement: The project site is located on Cal Poly Humboldt campus, the present and ancestral homeland and unceded territory of the Wiyot Tribe and People. Tribes and Nations in Humboldt County include Hupa, Karuk, Mattole, Tolowa, Wailaki, Wiyot, Yurok. We make this land acknowledgement in recognition that our words must be matched by action and approach.

The project site for feasibility test fit is located just south of the existing Schatz Center building and on the north end of parking lot G14 with access from B Street. The project will require the demolition of the existing Jensen House which will be unoccupied/unused after the Children's Center staff and office space is relocated to the Trinity Annex Children's Center that is currently under construction.

VISION PILLARS AND PRIORITIES

Based on strategic stakeholder engagement workshops conducted at the beginning of the Feasibility Study process, the following vision pillars and priorities were derived for this project.

- **Innovative Excellence** – Develop a world class microgrid and distributed renewable energy laboratory to support research, sustainable education. A place to showcase applied research in action with a demonstration of new technology, behavior and practice.
- **Future Ready Resilience** – Engage and retain students with hands on learning opportunities that prepare them for a rapidly changing and challenging future. Flexible spaces that support interdisciplinarity and mixed methods of research and instruction to bridge the gap between hardware, software and convening.
- **Community Persistence** – Create a welcoming and inclusive learning community that is a valued resource and actively demonstrates sustainability practices, puts research on display that is accessible and supportive of campus and civic community stakeholder needs.
- **Social and Environmental Justice Leadership** – Demonstrate commitment to sustainability where growth meets social, economic, and environmental balance, as well as achieves Carbon Net Zero and LEED Gold. Provide a place that prioritizes human centered and ecologically restorative practices including and community resilience.
- **Future Proofing** - Provide Infrastructure that is flexible and adaptable to support microgrid testing and an evolving industry.

SPACE PROGRAM SUMMARY

The Feasibility Program initiated with a space program of 25,000 GSF. This initial baseline program represented the following primary features:

- Microgrid Technology Research Spaces including a Grid Simulation Lab, Outdoor Lab Space as enclosed yard with vehicular access, Roof Solar Lab and Training Lab/Classroom along with Lab support and storage spaces.
- Workspace will provide offices for designated Energy Research and Office of Sustainability staff along with open workstations for designated students and related storage respective student groups conducting business at the center.

- Shared collaboration spaces will include a Seminar/Workshop Space with a highly flexible configuration, Medium Conference space and huddle rooms for flexible in person or hybrid meeting needs.
- Other shared resource spaces include a Reception waiting area with desk, Resource Center/Library, Work Room with copy and storage features along with a Breakroom and Wellness/Lactation room.
- Inclusion of limited conference rooms and an existing maintenance shop

1.2 PROCESS + FRAMEWORK

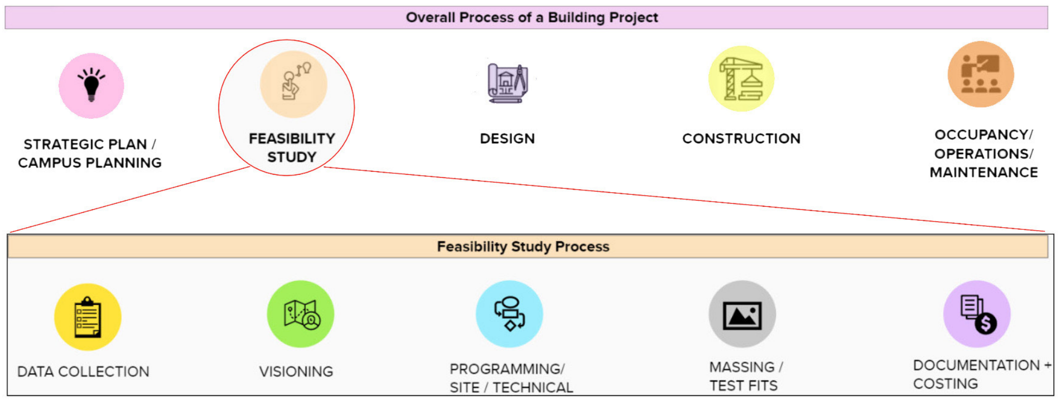
The Energy Research and Sustainability Center Feasibility Study summarizes the results of a visioning, programming and planning efforts for Cal Poly Humboldt. The process of this study also introduces a new framework of stakeholder engagement that embodies the values and culture while also supporting the goals identified in Cal Poly Humboldt's Future Forward Strategic Plan 2021-2026.

The Feasibility Study scope includes the following:

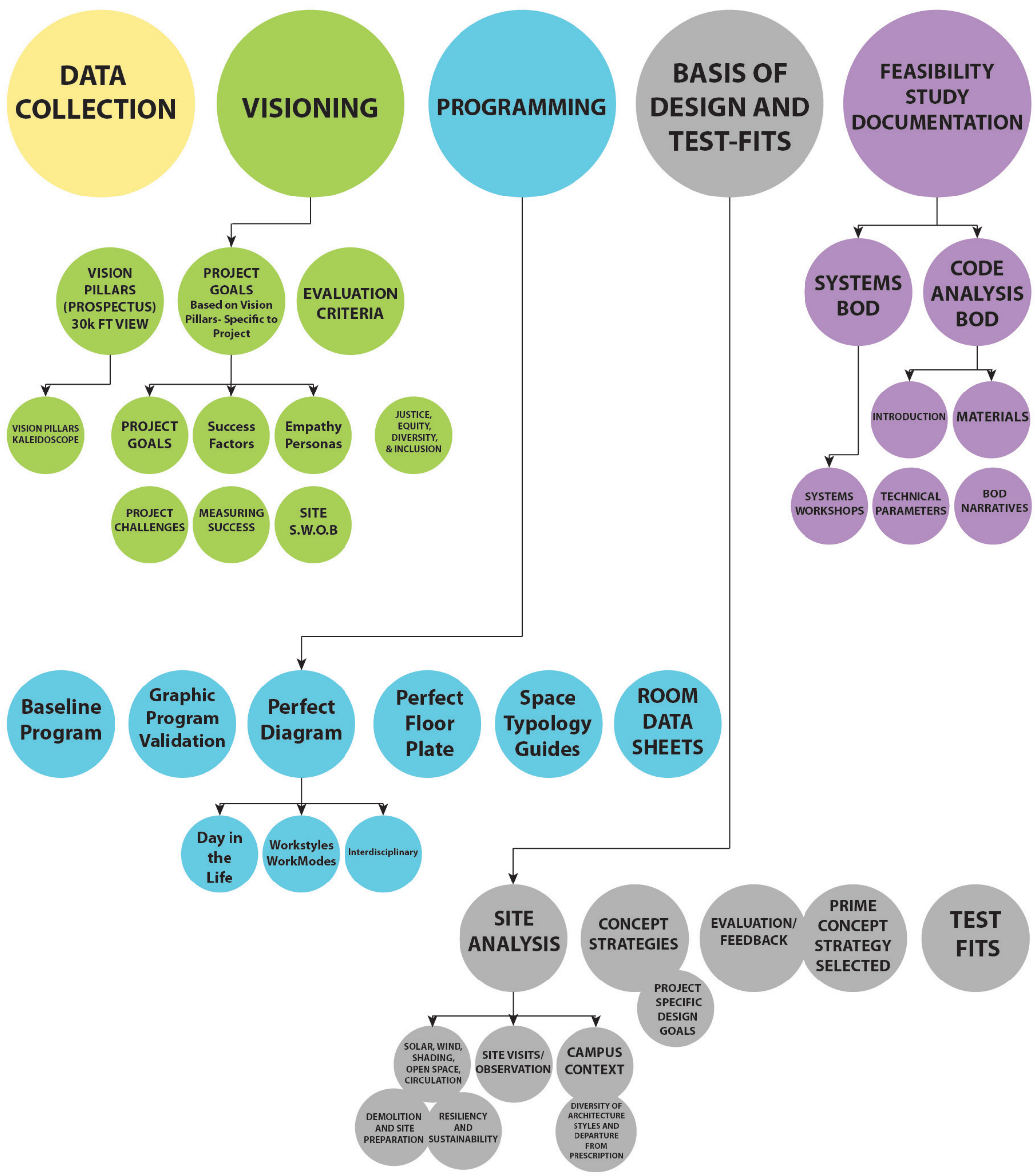
- Project Vision Pillars
- Space Program Requirements
- Site Analysis
- Design Process Framework
- Integrated Sustainability Approach
- Systems criteria outlines for Civil, Architecture, Laboratory Planning, Structural, Mechanical, Plumbing, Electrical, Audio-Visual and Telecommunications
- Building Code Analysis

The feasibility study process for this project started with a comprehensive strategic visioning framework in alignment with Cal Poly Humboldt newly adopted Future Forward Strategic Plan 2021-2026. The feasibility consultant team hosted several workshops to define project specific vision pillars, understand the program's goals and challenges, site related issues, success factors, metrics of success and empathy building. The goal of these workshops was to strengthen stakeholder engagement, trust and understanding while also defining project priorities and building consensus. The Cal Poly Humboldt Energy Research, Office of Sustainability, and Facilities working group members collectively determined a clear set of evaluation criteria based on the declared vision pillars and project priorities. Subsequently, the evaluation criteria are leveraged to streamline decision making during the concept test fits strategies and constraints – promoting discussion and health debate about advantages and unresolved challenges of each concept.

PROJECT PROCESS DIAGRAM



FEASIBILITY STUDY STRUCTURE



1.3 FEASIBILITY STUDY TEAM

The following individuals participated in the development of the Energy Research and Sustainability Center Programming and Feasibility Study Report and were instrumental in shaping the outcome of the study. Their time and commitment are greatly appreciated.

Campus Teams

Energy Research

- Arne Jacobson
- Peter Lehman
- Peter Alstone
- David Carter
- Steve Richards
- Allison Hansberry
- Marc Marshall.

Office of Sustainability

- Katie Koscielak
- Morgan King
- Jennifer Ortega
- Andrea Alstone

Facilities

- Michael Fisher
- Kassidy Banducci
- Howard Maxwell

Project Team

Architecture - Suarez-Kuehne
- John Suarez

Architectural Consultant - SmithGroup
- Rosa Sheng
- Laura Allen
- Rich Kirr
- Bill Katz
- Diane Kase
- Jason Campbell
- Siyu Chen
- Aaron Fu
- Rishika Gokhale
- Andrew Thurlow

Civil Engineering - Sherwood
- John Leys
- Andy Leahy
- Andrea Fortun
- Maika Nicholson

Landscape - SmithGroup
- Todd Kohli
- Meghan Storm

Structural - Rutherford & Chekene
- David Bleiman

Mechanical - SmithGroup
- Stet Sanborn
- John McDonald

Plumbing - SmithGroup
- Jennifer Ma

Electrical - SmithGroup
- Harold Pintes

Project Team, Continued

Energy-Grid Consulting - SmithGroup

- Katrina Kelly-Pitou

AV / IT - Salter

- Kenneth Graven
- Ryan Raskop

Telecom - TEECOM

- Adam Wrzeski
- Arnel Avila
- Lloyd Ranola

Lighting - SmithGroup

- Matt Aleman
- Nathan Sharnas

Acoustic - CSDA

- Randy Waldeck
- Aditya G Balani

Life Safety - H & S Associates

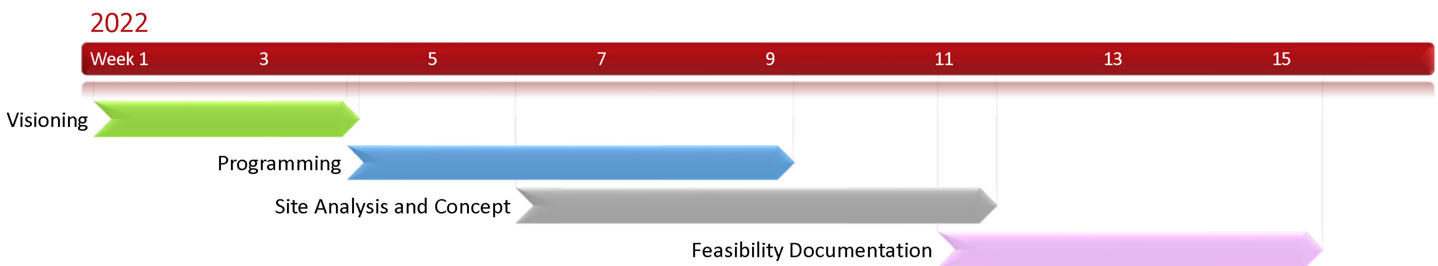
- Hans Hennerbeque

Cost - OCMI

- Conor Clarke
- Heike Salewski
- Abdullah Al-hourani

1.4 SCHEDULE

The Feasibility Study was a 5-month process commencing in February 2022 and concluding in August 2022. Following the Feasibility Study, the Energy Research and Sustainability Center (ER+SC) is anticipated to be delivered via Cal Poly Humboldt's Collaborative Design-Build delivery method. Phase 1 of this process (design) is intended to be executed in September 2022. Phase 2 (design-build) is planned to commence Q1 2023. The project is expected to be completed by July 2025 in time for occupancy by the fall semester.



02
PROJECT VISION

2.1 VISIONING SUMMARY

The feasibility study process for this project started with a comprehensive strategic visioning process in alignment with Cal Poly Humboldt newly adopted Future Forward Strategic Plan 2021-2026. The feasibility consultant team hosted several workshops to define project specific vision pillars, understand the program's goals and challenges, site related issues, success factors, metrics of success and empathy building. The goal of these workshops was to strengthen stakeholder engagement, trust and understanding while also defining project priorities and building consensus. The Cal Poly Humboldt ER+SC working group members collectively determined a clear set of evaluation criteria based on the declared vision pillars and project priorities. Subsequently, the evaluation criteria are leveraged to streamline decision making during the concept test fits strategies and constraints – promoting discussion and health debate about advantages and unresolved challenges of each concept.

Based on strategic engagement workshops conducted at the beginning of the Feasibility Study process with the working group, the following vision pillars and priorities were derived for the Energy Research + Sustainability Center project.

- **Innovative Excellence** – Develop a world class microgrid and distributed renewable energy laboratory to support research and sustainable education. A place to showcase applied research in action with a demonstration of new technology, behavior and practice.
- **Future Ready Resilience** – Engage and retain students with hands on learning opportunities that prepare them for a rapidly changing and challenging future. Flexible spaces that support interdisciplinarity and mixed methods of research and instruction to bridge the gap between hardware, software and convening.
- **Community Persistence** – Create a welcoming and inclusive learning community that is a valued resource and actively demonstrates sustainability practices, puts research on display that is accessible and supportive of campus and civic community stakeholder needs.
- **Social and Environmental Justice Leadership** – Demonstrate commitment to sustainability where growth meets social, economic, and environmental balance, as well as achieves Carbon Net Zero and LEED Gold. Provide a place that prioritizes human centered and ecologically restorative practices and community resilience.
- **Future Proofing** - Provide Infrastructure that is flexible and adaptable to support microgrid testing and an evolving industry.

2.2 ALIGNMENT OF PURPOSE

In defining the work and alignment of vision and goals for this project, it is important to understand and combine the purpose and vision of the prime project stakeholders at various levels – Cal Poly Humboldt at the institutional campus level and the Schatz Energy Research Center and the Office of Sustainability at the project scope level.

2.2.1 CAL POLY HUMBOLDT - A POLYTECHNIC VISION

The purpose* of Cal Poly Humboldt is: To provide the highest quality and affordable college education built on the contributions of diverse students, staff, and faculty who are committed to a just and sustainable world.

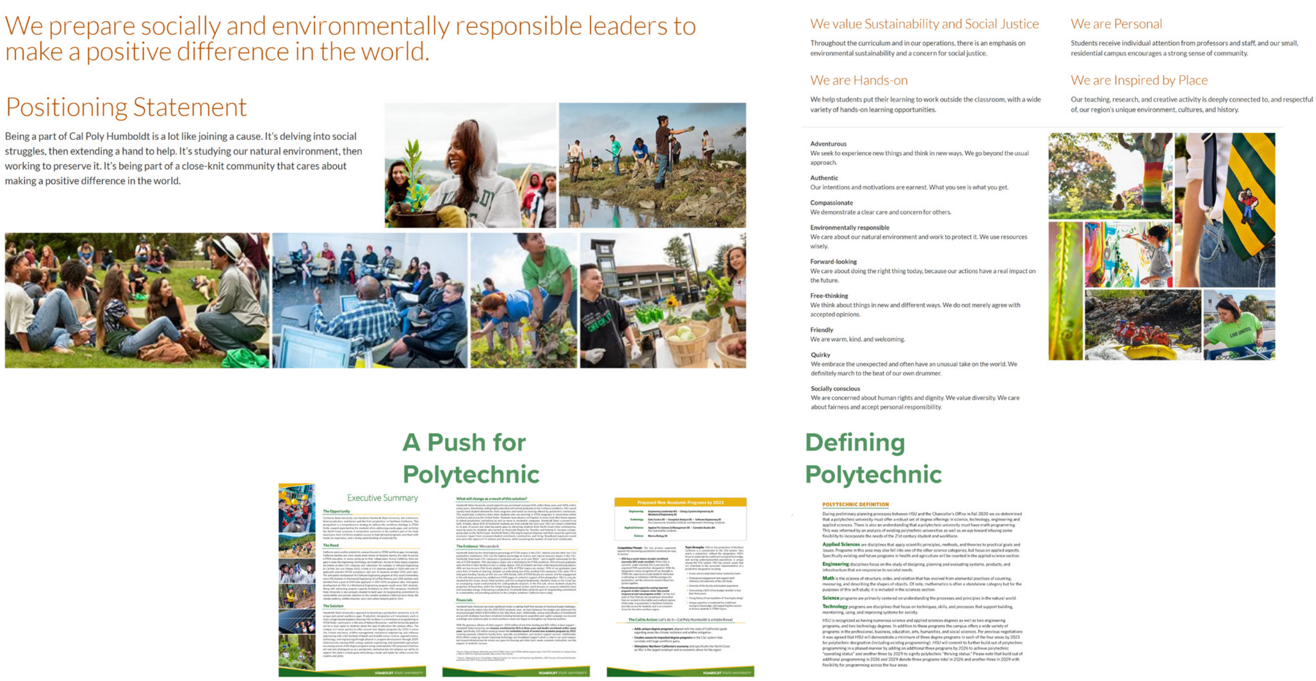
**The Diversity, Equity & Inclusion Council recommended a change of Humboldt's "Mission" to "Purpose" to acknowledge that Humboldt sits on unceded land initially occupied by the first people of this area. The word "Mission" for many connotes colonial language.*

Since its beginning in 1913, Cal Poly Humbodt has provided generations of students with unique educational experiences built upon the motto, Discere Faciendo or Learning by Doing in a place-based, inclusive learning community of faculty, staff, and students who live, work, and study within a residential Northern California setting. Today, Cal Poly Humboldt is a comprehensive university serving not only the local region, but also the state, the nation, and the world, through instruction, research, and public service.

In preparation to becoming a polytechnic university, Cal Poly Humboldt was required to submit an in-depth and honest look at strengths and aspirations. The community worked together on a comprehensive self-study -- the Polytechnic Prospectus, conducted with critical input and collaboration from staff, faculty, students, alumni, and stakeholders.

Recognizing the impact of the California State University on the state's economy and workforce, the State of California made a significant investment of $458 million in the 2021-22 state budget to help propel Humboldt State University's transition to become a polytechnic university. The funding will enable California State Polytechnic University, Humboldt to add new academic programs that will help

Figure 2.2.1 - Positioning Statement



fill workforce gaps, modernize existing facilities, and build new infrastructure and increase access for the state's students seeking science, technology, engineering and math (STEM) degrees.

After the self-study process was completed and the polytechnic prospectus was submitted to the CSU Board of Trustees, an unprecedented effort began. Working groups were charged with the Polytechnic Implementation of the University's polytechnic vision with bold, innovative, and forward-looking plans.

Additionally, Cal Poly Humboldt's "Future Forward: 2021-2026 Strategic Plan," outlines the University's purpose, values, and goals. The plan articulates the University's vision "to be a campus for those who seek, above all else, to improve the global human condition and our relationship with the environment."

To support that vision, the University has established six key themes:

- **Academic Roadmap**: Providing recommendations for advancing academic excellence and access. The Humboldt Academic Roadmap promotes distinctive, innovative academic programs and ways of instruction centered on the curricular needs for well-prepared students, including our support and development of programs that assist Humboldt in achieving the polytechnic designation.

- **Community Collaboration & Shared Success**: Working together, sharing resources, communicating openly, and creating an inclusive and welcoming environment.

- **Employee Engagement & Success**: Ensuring all Humboldt employees—faculty, stateside and auxiliary staff, administrators, and student employees—have what they need to be involved in, enthusiastic about, and committed to their work and to Humboldt.

- **Future Proofing Humboldt**: Creating the type of university that can adapt and thrive in the future and respond effectively to internal and external challenges and opportunities.

- **Resources Stewardship & Sustainability**: Promoting goals that appropriately generate, manage, and invest resources toward the purpose of the University and its adopted guiding plans, through the common lens of "student first," equity, inclusivity, and sustainability.

- **Student Experience & Success**: Identifying and building strategies that promote positive and meaningful student engagement experiences and success.

Figure 2.2.2 - Humboldt Purpose, Vision, and Core Values and Beliefs

Humboldt's Purpose*

To provide the highest quality and affordable college education built on the contributions of diverse students, staff, and faculty who are committed to a just and sustainable world.

**The Diversity, Equity & Inclusion Council recommended a change of Humboldt's "Mission" to "Purpose" to acknowledge that Humboldt sits on unceded land initially occupied by the first people of this area. The word "Mission" for many connotes colonial language.*

Vision

Cal Poly Humboldt will be a campus for those who seek *above all else* to improve the global human condition and our relationship with the environment. Toward this:

We will be the premier center for the interdisciplinary study of the environment, climate crisis and resilience to climate change, and the conservation of ecological systems and natural resources. Our focus will continue to be on sustainability through environmental, economic, and socially responsible action.

We will be a center for the interdisciplinary study of just global societies. We will approach our work with an equity mindset and continue to emphasize inclusion across multiple dimensions of our university, modeling what we want to see in the world.

We will serve as a regional center for the arts inclusive of diverse arts traditions and contributions, and will fully engage with community arts partners and employers on behalf of our students.

As a designated Hispanic-Serving Institution (HSI) and as a Minority-Serving Institution (MSI), **we will** be an institution in which Black, Indigenous, and Persons of Color (BIPOC) students thrive.

We will partner with Indigenous communities to address the legacy of colonialism, and create space nurturing of traditional ecological knowledge (TEK), pedagogies, and curricula responsive to their identified needs.

We will be exemplary partners across our region and state by integrating community engagement and contributing to workforce development in our academic enterprise and beyond.

Core Values and Beliefs

The following values and beliefs serve as our guiding "north stars" for accomplishing our collective purpose and goals:

Connection to Place We value place-based teaching, learning, and scholarship, taking our educational enterprise outside and into our communities.

Creativity We believe creativity is central to human and organizational growth and responsible collective action.

Decolonized Knowledge We value diverse systems of knowledge and ways of knowing. We believe in centering stories and knowledge that have been marginalized in oppressive social arrangements.

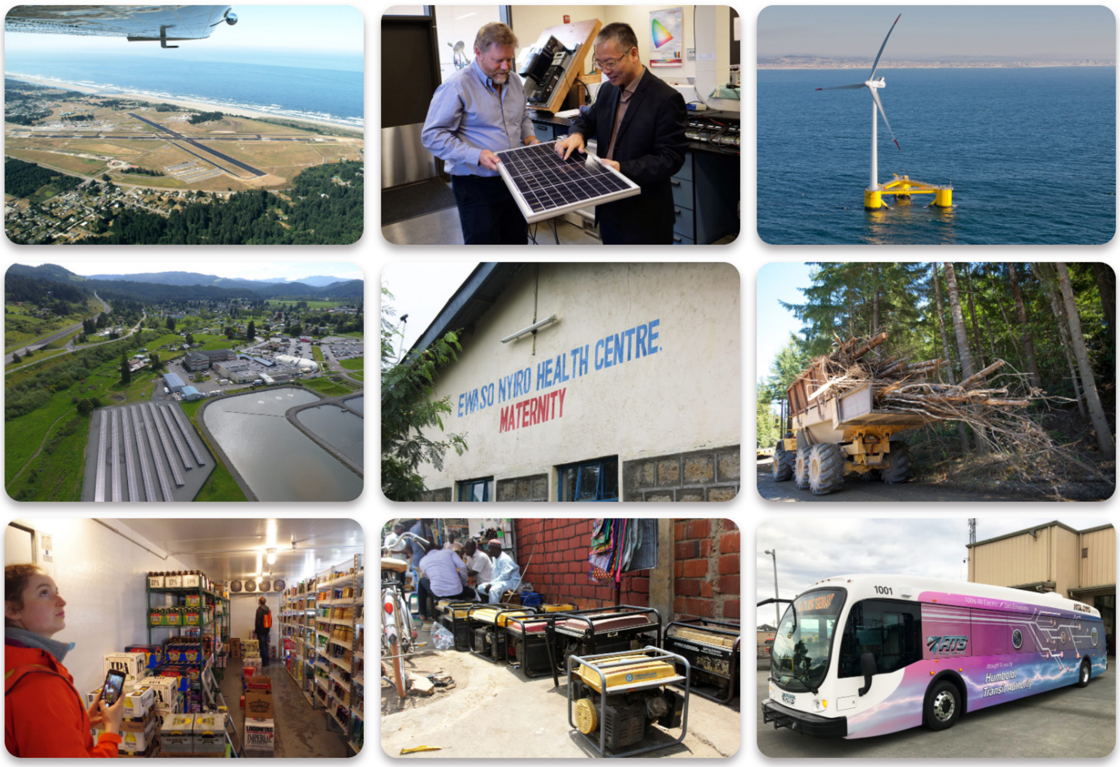
Human Dignity We believe in the dignity of all and in equitable treatment, opportunities, and outcomes.

Free and Critical Inquiry We value academic freedom, reflexivity, and serving as a repository of accumulated knowledge that is accessible to the broader community.

Shared Governance and Participatory Planning We believe that our collective processes and outcomes will be strongest when they emerge from shared governance and collaboration.

Social Responsibility and Civic Engagement We value contributions in the public interest and environmental, economic, and social responsibility in our work toward viable and sustainable communities.

Figure 2.2.3 - Schatz Energy Research Center Purpose



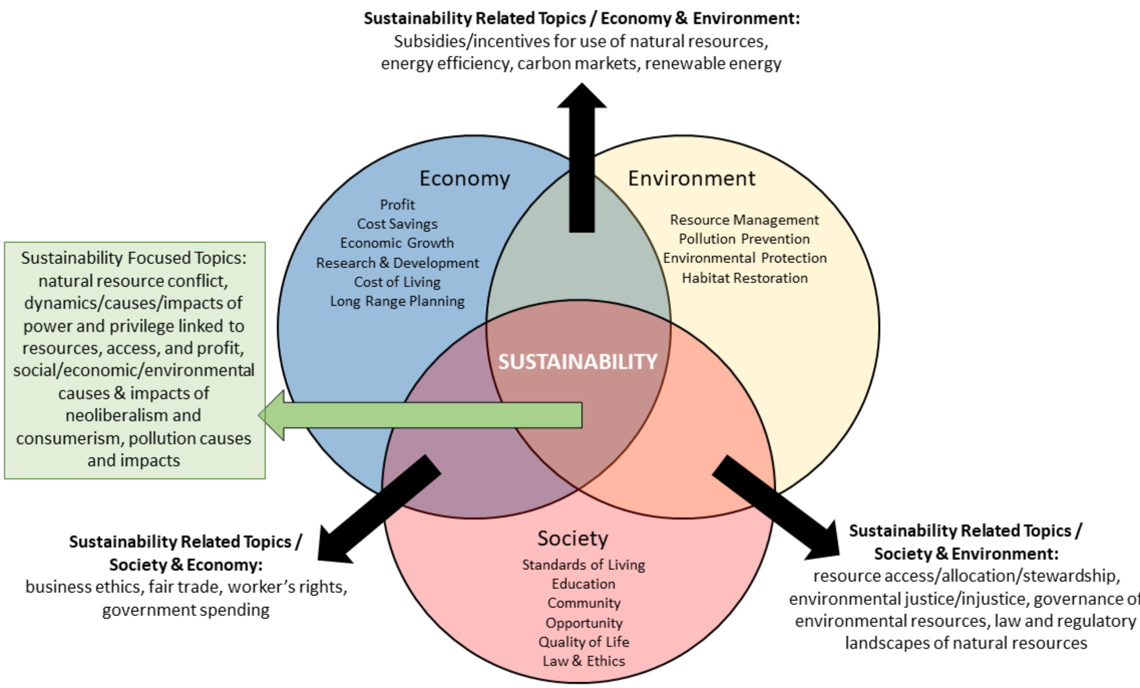
2.2.2 SCHATZ ENERGY RESEARCH CENTER

The purpose of the Schatz Energy Research Center is to promote the use of clean and renewable energy. This is accomplished by:

- Designing, demonstrating, and deploying clean and renewable energy technologies
- Implementing collaborative programs that support the deployment of clean energy systems
- Performing lab and field research
- Engaging in scientific and policy analysis
- Providing graduate fellowships and work opportunities for student engineers and scientists
- Educating the public about clean and renewable energy

Since 1989, the Schatz Center has produced groundbreaking, renewable energy solutions that reduce climate change and pollution while increasing energy access and resilience. Located on the campus of Cal Poly Humboldt, the Schatz Center's research efforts include microgrids, offshore wind, off-grid energy access, carbon life cycles, clean transportation, and more. The Center works closely with state agencies, local government, and Tribal nations in our region, as well as with the World Bank Group, CLASP, IKEA Foundation, and others to support international energy access and resilience.

Figure 2.2.4 - Sustainability Tracking Assessment and Rating System



2.2.3 OFFICE OF SUSTAINABILITY

Sustainability is the recognition that humanity is a part of the natural world, not separate from it, and that healthy social and economic systems depend on the resilience of ecological systems.

STARS (the Sustainability Tracking Assessment and Rating System) is a well-respected and deeply vetted tool for stakeholders at institutions of higher education to understand and report on sustainability. As such, this group provides the following text when describing sustainability in the Technical Manual (2018, version 2.1, page 14):

"Popular representations of sustainability underscore the concept's three dimensions. Sustainability experts often use a three-legged stool as a symbol for sustainability. The social, economic, and environmental components each represent one of the stool's legs. If one of the legs is missing, the sustainability stool can't balance or function. A common illustration of sustainability is the diagram depicting three overlapping circles representing environmental needs, economic needs, and social needs. The area where the circles overlap, and all three needs are met is the area of sustainability."

2.3 PROJECT PARAMETERS

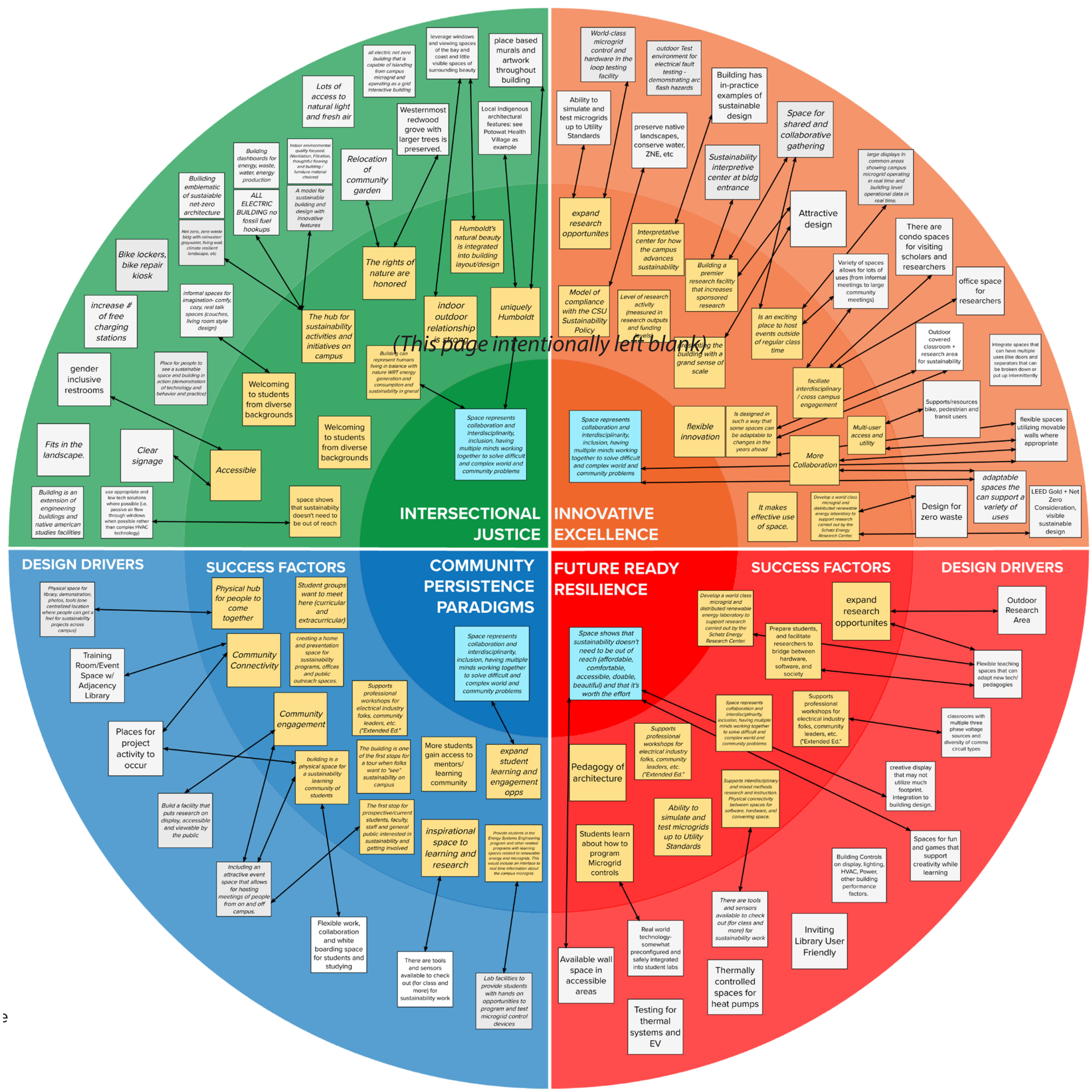
The Energy Research and Sustainability Center project is a unique opportunity for creating a new hub that combines the efforts of clean and renewable energy research with holistic sustainability goals through collaborative community partnerships, resource sharing and education. Based on the ecosystems approach to sustainability, the project program will support research, collaboration and education facilities for Microgrid energy technology implementation and broader sustainability goals for the campus.

In this context, Cal Poly Humboldt has begun development of a renewable energy microgrid to support campus resilience through clean generation. This microgrid will be part of the campus' sustainability framework, and will enable students in engineering, environmental sciences, and other programs to gain hands-on experience with innovative climate-friendly technologies. As such, the new build elevates the importance of climate action and social and environmentally just initiatives while cultivating a culture of human centered empathy and values amongst staff, educators, students, community members and public/private partners.

2.4 VISION PILLARS AND SUPPORTING GOALS

In the visioning section of the feasibility study, the ER+SC project working group's stakeholders were prompted with a series of workshop exercises that captured the collective goals and challenges, success factors, metrics of success, and observational strength, weaknesses, opportunities and barriers attitudes about the project's proposed site location. The following sections summarize the workshop process and key outcomes to note in the above-mentioned areas.

Figure 2.4.0 - Vision Pillar Strategic Goals



2.4.1 EXERCISE 1: PROJECT GOALS AND CHALLENGES

PURPOSE

This exercise supported stakeholders in voicing their aspirations and concerns about the project in a crowdsourced format on virtual post-its followed by discussion. The format promotes interdisciplinarity, allows for transparent discussion in a safe forum while maximizing feedback and promoting healthy debate and listening to differing points of view. The exercise was conducted virtually, and participants were asked to populate the board with multiple goals and challenges prior to the discussion.

SUMMARY OF PRIORITIES

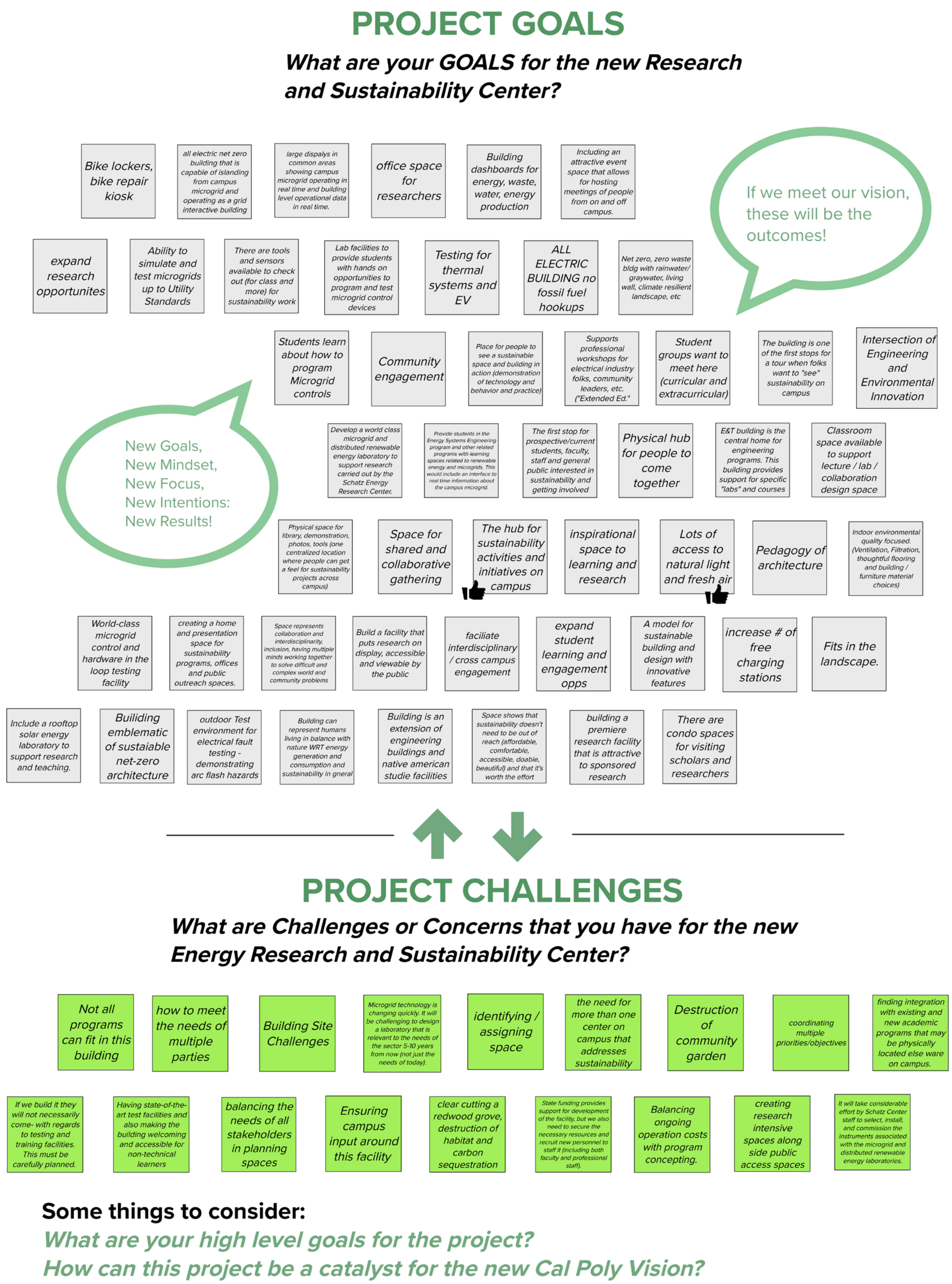
Key project GOALS for the group include the following:

- Develop a world class microgrid and distributed renewable energy laboratory to support research carried out by the Schatz Energy Research Center.
- Showcase a welcoming hub that represents collaboration and interdisciplinarity, inclusion, having multiple minds working together to solve difficult and complex world and community problems.
- Provide Cal Poly Humboldt students in Energy Systems Engineering and related programs with renewable energy and microgrid learning spaces - include an interface to real time information from the campus microgrid.
- A building that can demonstrate humans living in balance with nature- renewable energy generation /consumption and sustainability.

Key project CHALLENGES for the group include the following:

- Developing a state-of-the-art research facility while also creating an inclusive and accessible place for sustainability education of non-technical learners and the community at large.
- Creating a space where Energy Research and Office for Sustainability have equal presence and clear navigation of collaboration and secured testing areas to serve the needs of diverse constituents.
- Designing a infrastructure that is relevant to the today's requirements while also providing flexibility to adapt over time as Microgrid technology is rapidly changing and evolving.
- Finding integration with existing and new academic programs with accessibility in mind – both physically and culturally with the site at the southern edge of campus.
- Creating a front door presence to campus, while also navigating the habitat impact of building in and around the existing redwood grove on steep sloped terrain.

Figure 2.4.1 - Project Goals and Challenges



2.4.2 EXERCISE 2: SUCCESS FACTORS AND MEASURING SUCCESS

PURPOSE

This exercise built upon the established project goals and challenges and asked the working group stakeholders to provide more detailed descriptions of success factors and metrics of success that would begin to shape ideas of physical characteristics of spaces within the program. The success factors and metrics would also be leveraged to make connections between vision pillars, goals/challenge to establish criteria for creating program adjacency priorities and evaluating concept test fit options.

SUMMARY OF PRIORITIES

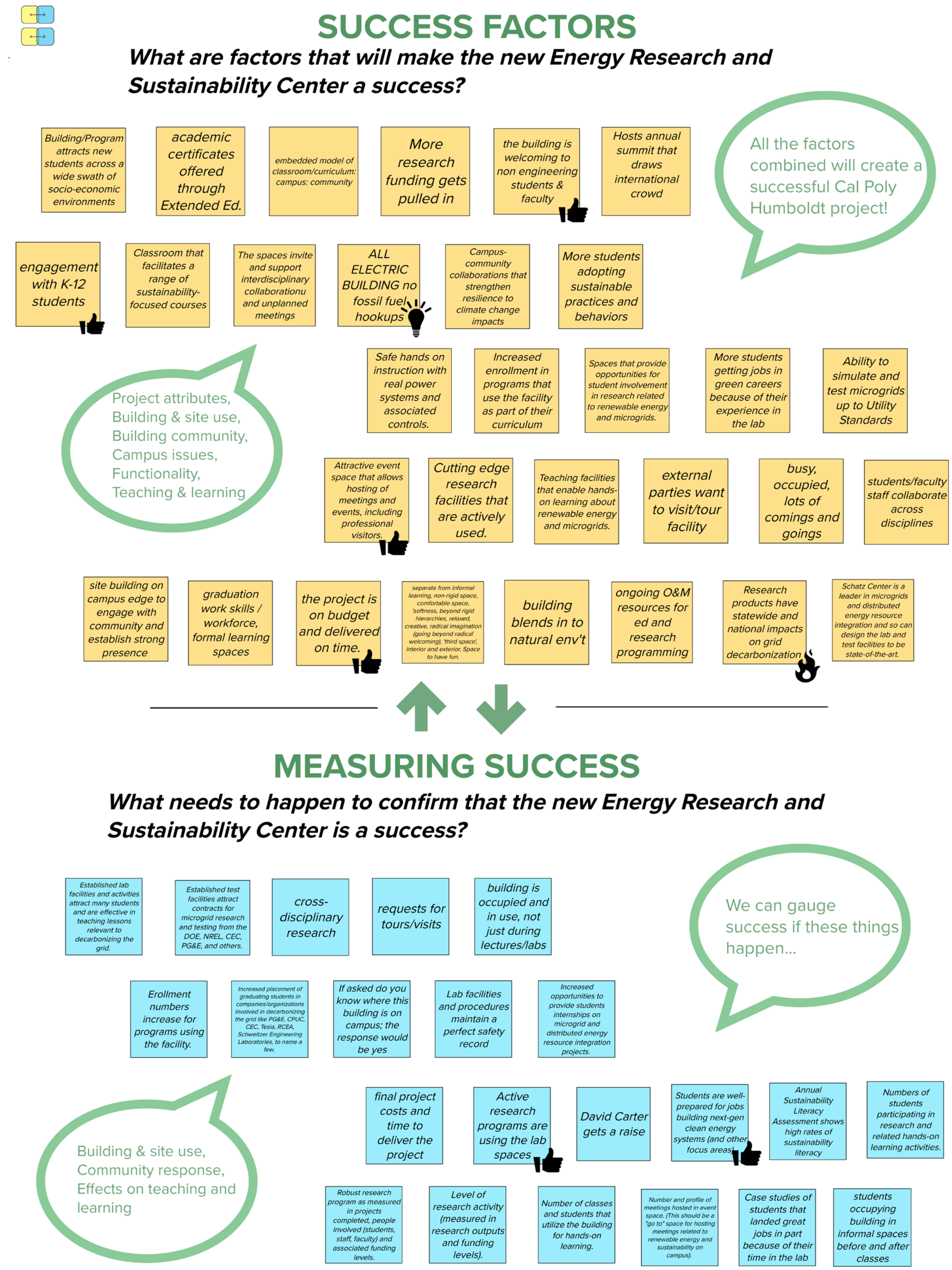
Key project SUCCESS FACTORS for the group include the following:

- Building/Program attracts new students across a wide swath of socio-economic environments
- The spaces invite and support interdisciplinary collaborationu and unplanned meetings
- Teaching facilities that enable hands-on learning about renewable energy and microgrids.
- Site building on campus edge to engage with community and establish strong presence with attractive event space that allows hosting of meetings and events, including professional visitors.
- ALL ELECTRIC building with no fossil fuel hookups that is also on budget and delivered on time.
- Design the lab and test facilities to be state-of-the-art to build upon Schatz Center reputation as a leader in microgrids and distributed energy resource integration

Key project METRICS OF SUCCESS for the group include the following:

- Increased intern placement for students and job offers new graduates from next-gen clean energy systems companies/organizations involved in decarbonizing the grid like PG&E, CPUC, CEC, Tesla, RCEA, Schweitzer Engineering Laboratories, etc.
- Established test facilities attract contracts for microgrid research and testing from the DOE, NREL, CEC, PG&E, and others.
- Robust research program as measured in projects completed, people involved (students, staff, faculty) and associated funding levels.
- Number and profile of meetings hosted in event space. (This should be a "go to" space for hosting meetings related to renewable energy and sustainability on campus).

Figure 2.4.2 - Success Factors and Measuring Success



Some things to consider:

Success at a campus scale
Success at a curriculum scale
Success at a teaching/research level
Success at an individual student scale

2.4.3 EXERCISE PART 3: SITE STRENGTHS, WEAKNESSES, OPPORTUNITIES, AND BARRIERS

PURPOSE

This exercise allowed for the working group stakeholders to assess, share and discuss key perceptions about the site characteristics both in existing conditions and future potential for this project. Strengths and weaknesses provided focus on the current state of the site, while Opportunities and Barriers provided focus on the future state of the site. The exercise also encouraged the group to evaluate in the context of campus mobility, land uses, program adjacencies, ecology and orientation, and image/identity.

SUMMARY OF PRIORITIES

Key Perceived SITE STRENGTHS for the group include the following:

- Adjacency to Schatz Energy Building, Center Canter for Appropriate Technology (CCAT), and Food Sovereignty Lab.
- Adjacency to key planned infrastructure for the campus microgrid.
- The hillside site maximizes land use for campus and preserves other land for future development.

Key Perceived SITE WEAKNESSES for the group include the following:

- circulation will be limited due to the proximity to parking, fire lanes, and forested areas
- Site does not have a strong connection/visibility to main campus circulation due to steep hills between.
- Developing the building will involve cutting redwoods. Strong desire to limit removal of larger trees.

Key Perceived SITE OPPORTUNITIES for the group include the following:

- De-emphasize passenger vehicles in favor of covered bike parking and walk-in accessiblity
- Introduce a more formal presentation of the hillside complete with walking paths, proper earth retainment.
- Improve accessibility to Schatz Center (parking-lot level entry + elevator + level hardscape to 1st floor at existing center)

Key Perceived SITE BARRIERS for the group include the following:

- Clear-cutting a redwood grove and removing a community garden for a sustainability/microgrid lab?
- Steep site creates accessibility challenges and fire truck access to future build
- Safety issues given the edge of campus and remote nature from the center of campus.

Figure 2.4.3 - SWOB Exercise

EXERCISE:
Fill in the matrix post-its to show department curriculum synergies and overlaps.

Participants can also voice their thoughts and use the chat window to write their input. The design team will add them to post-its.

The **SWOB** analysis has been broken down into five topic areas:

1. **Circulation and Parking**: pedestrian, bicycle, public transit and vehicular mobility to/from the site and within the site.
2. **Land Uses, Architecture and Streetscape**: types of uses and activities; architectural details of the DRT and other surrounding buildings; and streetscape amenities such as lighting and seating.
3. **Programs & Adjacent Buildings:** Synergies and relationships to adjacent sites and buildings and the existing and potentially new uses
4. **Environmental**: sunlight and wind, air quality, vehicle trip reduction and stormwater management.
5. **Image and Identity**: the unique qualities and characteristics of the site that will set it apart from other areas in the city and on campus.

STRENGTHS — POSITIVE PHYSICAL CHARACTERISTICS - EXISTING

1 Strengths refer to the existing conditions of the site, which are either helpful to achieving the goals of the project. Strengths are favorable conditions that need to be built upon.

CIRCULATION AND PARKING	nearby parking at lot 14				
LAND USES, ARCHITECTURE, and STREETSCAPE	selecting the hillside site would maximize land use for our campus and preserve other land for future development.				
PROGRAMS AND ADJACENT BUILDINGS	Building is adjacent to the Schatz Center.	Building is near key planned infrastructure for the campus microgrid.	building is near CCAT, Schatz, Food sovereignty lab	Building is relatively near the engineering and technology building (albeit not immediately adjacent).	
ENVIRONMENTAL	students who learn in this building could have broad impact towards more sustainable society	South facing sloped site			
IMAGE and IDENTITY	Sustainability hub of campus	Demonstrating decarbonized electricity grids and microgrids	Hands on learning experiences in grid decarbonization	Accelerating grid decarbonization through advanced hardware-in-the-loop testing and microgrid modelling.	

WEAKNESSES

2 Weaknesses refer to the existing conditions of the site, which are harmful to achieving the goals of the project. Unfavorable conditions need to be considered in the design and planning of the future project.

CIRCULATION AND PARKING	circulation will be limited due to the proximity to parking, fire lanes, and forested areas	steep hills between this site and main campus	the parking lot is not beautiful	Not good bike parking in that area	need for sidewalks / walkways	
LAND USES, ARCHITECTURE, and STREETSCAPE	accessibility is going to be a challenge of this building.	hillside	should be developing land that is repurposed (Children's Center) and rehabed. Source existing utilities and clean up south edge of campus			
PROGRAMS AND ADJACENT BUILDINGS	Space is a bit tight for the outdoor test facilities					
ENVIRONMENTAL	Developing the building will involve cutting some redwoods. Strong desire to limit removal of larger trees.	potential effect on wildlife				
IMAGE and IDENTITY	Site does not have a strong connection/ visibility to main campus circulation					

OPPORTUNITIES — POSITIVE PHYSICAL CHARACTERISTICS - FUTURE POSSIBILITY

3 Opportunities refer to potential future conditions of the site. Potential improvements and favorable conditions that the project will seek to achieve. Opportunities need to be prioritized.

CIRCULATION AND PARKING	reserved parking spot(s) for EVs	De-emphasize passenger vehicles in favor of covered bike parking and walk-in accessiblity	funicular?	shared loading access with Schatz	
LAND USES, ARCHITECTURE, and STREETSCAPE	solar exposure - south facing slope with open sky	smart design could improve accessibility to Schatz Center (parking-lot level entry + elevator + level hardscape to 1st floor at existing center)	Demonstration of climate resilient/ pollinator friendly landscaping		
PROGRAMS AND ADJACENT BUILDINGS	collaboration with CCAT	Adjacency to Schatz Center for moving people and equipment back and forth	Rooftop laboratory can provide space for hands-on solar energy research.	Creation of clean energy / sustainability themed event space for hosting meetings and workshops.	
ENVIRONMENTAL	a great opportunity to work with the existing redwood grove.	For trees that need to be cut, mill into lumber that is used in the building			
IMAGE and IDENTITY	introduce a more formal presentation of the hillside complete with walking paths, proper earth retainment.	Building that can help the university showcase its clean energy and sustainability values and credentials.			

BARRIERS — PROBLEMATIC PHYSICAL CHARACTERISTICS - FUTURE RISK

4 Barriers refer to potential future conditions of the site. The potential risks that may impede the realization of project goals. Barriers need to be countered or minimized.

CIRCULATION AND PARKING	limited parking	steep site creates accessibility challenges				
LAND USES, ARCHITECTURE, and STREETSCAPE						
PROGRAMS AND ADJACENT BUILDINGS						
ENVIRONMENTAL						
IMAGE and IDENTITY	Clear-cutting a redwood grove and removing a community garden for a sustainability/microgrid lab??? Oh, the irony! It won't be lost on our students	Removal of carbon sequestration when campus is trying to go carbon neutral				

2.4.4 EXERCISE PART 4: EMPATHY BUILDING

PURPOSE

This exercise was conducted with stakeholders in person to gain insights of student perspectives prior to a larger outreach opportunity to gain student feedback. Each participant was asked to assume the identity of a student persona that highlighted intersectional identities and unique lived experiences which include a spectrum of implicit challenges and potential bias for these individuals. Based on their persona, each stakeholder was also asked to identify potential challenges and opportunities that the student may encounter in approaching and utilizing the resources of this new building.

SUMMARY OF PRIORITIES

Key observations from the Empathy Building personas exercise

- Accessibility and Mobility challenges given the remoteness, lack of existing accessible pathways, and steep grade.
- Stigmas and bias about who may be perceived as belonging at the center given the safety concerns for injury around research equipment and access for those who are non-staff members while trying to maintain the welcoming nature of the building.
- Provision of "third space" student study/collaboration space for students who don't have access to on-campus housing while balanced with the programmed functions that would promote learning communities.
- Addressing needs for a wide range of building users – ie., mother's room, all gender restroom accommodations, showers for non-vehicular commuters, quiet room for nuerodiverse, etc.

Figure 2.4.4 - Empathy Building

CAL POLY HUMBODLT COMMUNITY

I am:	19 year old Persian American Transgender Person
My pronouns are:	They/Them/Theirs
I was raised by:	My parents in Iran, we immigrated to the U.S. - Chico, CA when I was 10
I currently live in:	Student Housing Eureka Intermodal Transit/Housing Center
I work as:	Graduate Student TA in Molecular Cell Biology at Humoboldt Cal Poly
I worship:	I am Muslim, it is hard to find places for daily prayer
I enjoy:	Cooking, Iranian/Persian cultural events, Spending time w/ Friends
I get around by:	Bicycle, public transportation, or walking
You may not know that:	I am high functioning on the Autism Spectrum,

I am:	32 year old Mexican / Native American Cisgender Woman
My pronouns are:	She/Her/Hers
I was raised by:	My single dad in Oakland, whom I visit once every 2 months
I currently live in:	Apartment w/ 2 roommates and daughter in Arcata near campus
I work as:	Registered Nurse - VA Medical Clinic in Eureka
I worship:	Devoted Catholic
I enjoy:	Nature - Weekend hiking, Spending Time outdoors with my kids
I get around by:	Public transportation, borrowing friends car in Arcata or Short Term rental
You may not know that:	I am undocumented, I came with my parents when I was 10.

I am:	25 year old Nigerian Cisgender Man
My pronouns are:	He/Him/His
I was raised by:	My parents in Lagos , 3 siblings. They still live there.
I currently live in:	Arcata
I work as:	Hydrology - Assistant Professor , New Researcher at Schatz Energy Center
I worship:	Protestant Christian
I enjoy:	Birding, Painting and Sea Kayaking on the weekends
I get around by:	I have an old car for local, but prefer public transportation for regional
You may not know that:	I have survived cancer, but require prescription medication

2.5 EVALUATION CRITERIA

Based on the defined priorities from the Visioning workshop exercises and outcomes described above, the feasibility team facilitated the development of the evaluation criteria for the Energy Research and Sustainability Center concept test fits. The following is a summary of the evaluation criteria priorities in four main areas: Site Context, Function, Staff/Student User Experience, and Community.

1. Creates a Strong presence on cluster court and B-Street while having appropriate scale for the site context. (Site)
2. Strong Relationship to Schatz Center and CCAT that doesn't impact access to neighboring sites and height of building works with hillside and neighbors.) (Site)
3. Respectful of campus context (existing trees and impact on existing site) and user accessibility.Ease of Mobility and Circulation (Site)
4. Microgrid program adjacencies streamlined support world class research facility. (optimize functions) (Function)
5. In-Practice Sustainability integrated in all aspects of the building function and experience, Optimize solar orientation, etc (Function)
6. Fosters high collaboration between ER + SC users with highly functional and flexible relationships between areas (Function)
7. Research on Display - supports student belonging, curiosity and engagement in energy research and sustainability. (Staff/Student UX)
8. Organization supports informal learning with spaces that offer multiple uses and flexibility. (Staff/Student UX)
9. Spaces promote holistic wellness - natural light, views, indoor/outdoor connections. (Staff/Student UX)
10. Welcoming Hub with clear wayfinding and ease of navigation for students and community (Community)
11. Viewed as community resource with areas for public gathering and support (Community)
12. Accessible to All - universal access to site resources including, provisions to support exchange with larger community. (Community)

03
PROGRAM

3.1 PROGRAM DEVELOPMENT

The Energy Research and Sustainability Center Building programming process began with the Feasibility Team working closely with the working group stakeholders in a parallel process for the Visioning workshops to develop and align the Space Program. Through a series of workshops and meetings, baseline assumptions were reviewed, tested and refined to arrive at the Space Program on the following pages. The initial program narratives and the resulting Space Program are described in further detail below.

3.2 INITIAL PROGRAM NARRATIVES

The Feasibility Study initiated with a target Building Gross Area of 25,000. This program represented the following primary features as described by the Stakeholder Working Group:

3.2.1 DISTRIBUTED RENEWABLE ENERGY AND MICROGRID LABORATORY

(From 07.15.21 Distributed RE and Mircogrid Facility document. See Appendix for complete text.)

In this year's state budget, there is support to build a state-of-the-art Distributed Renewable Energy and Microgrid Laboratory, to be located adjacent to the Schatz Energy Research Center on the HSU campus.

BACKGROUND

California's energy system is undergoing a dramatic transition as the state works to meet the climate and clean energy goals specified in Senate Bill 100, including a target of 100% clean energy by 2045. Simultaneously, the state needs to increase the resilience of its energy system as it adapts to extreme weather and wildfire events associated with global warming. To meet these goals, California needs:

- *A skilled workforce that is ready to rapidly ramp up clean and resilient energy systems over the coming decades*
- *A state-of-the-art laboratory equipped to develop and test the technologies and designs necessary to install microgrids throughout the state*

VISION FOR THE FACILITY

The Distributed Renewable Energy and Microgrid Laboratory will support our students to become the next generation of energy professionals. It will enable deep engagement with cutting-edge, clean energy technology to understand how it works, run lab experiments, and invent and test new ideas. With real-world, hands-on experience, Humboldt Polytechnic students will be primed to deploy clean energy systems that can help us cut greenhouse gas emissions and improve community resilience.

We will build a modular and adaptable space where next-generation energy resources can be studied and advanced by students and researchers. The professionals at the Schatz Energy Research Center will use the lab to develop and test new concepts for microgrids and integrating clean energy systems. Students, guided by staff and faculty, will use the facility to learn about these systems in lab exercises, class projects, and by assisting Schatz Center engineers installing real-world cutting-edge systems.

With these new laboratory capabilities, a range of systems can be analyzed to support instructional needs across multiple disciplines and a range of research projects.

- *Microgrids - The core building block for resilient electricity systems to address wildfire risks and other threats to the power system, renewable microgrids increase resilience to the impacts of climate change and provide carbon-free electricity to the grid.*
- *Renewable energy power systems - Solar and wind power systems, battery storage, and related technologies are the clean-energy generation sources and energy storage systems that are needed to make microgrids and the larger grid sustainable and mitigate climate change.*
- *Advanced electric vehicle chargers, heat pumps, and cooling - The grid of the future will involve the use of flexible and efficient electric equipment that meets critical transportation, heating, cooking, and cooling needs with resilient clean energy.*

LABORATORY SPACES

The facility will be built around four dedicated, custom-designed laboratory facilities that support education and research.

1. ***State-of-the-art training laboratory & classroom** - A 12-station, 24-student lab equipped with grid simulation, signal generators, protection relays, etc., and electrically connected to the large research lab described below. Area: approximately 1,500 sf*
2. ***Ground floor, world class hardware-in-the-loop, grid simulation laboratory** - A large, high-bay lab space that houses control systems, high-performance computing simulation platforms, with the ability to test microgrid and other advanced grid systems. Area: approximately 1,500 sf*
3. ***Outdoor laboratory space** - Just outside roll-up doors from the ground floor lab space, the outdoor space will be a secure, safe, fenced area with electrical interconnection points and concrete slabs to mount outdoor-rated equipment under test. This flexible space will enable the lab to incorporate EV chargers, distributed battery storage systems, heat pumps, and other future energy systems. Area: approximately 2,000 sf*
4. ***Rooftop solar laboratory** - On the roof of the building, there will be a large, walkable "patio" lab space open to the sky for testing solar PV systems. With excellent access to sunshine, this space will be used to integrate real-time solar PV generation with the equipment and devices under test downstairs. Area: approximately 2,000 sf (about half of the roof)*

SUPPORTING INFRASTRUCTURE

These new facilities will be supported by The Schatz Energy Research Center's existing fabrication shop, meeting spaces, and general-purpose lab spaces. In addition, the new building will include additional support space for the Schatz Center Microgrid Lab, for new and existing staff. These spaces are conceived to primarily be on the second (and possibly third) floor of the new building, with a total of approximately 8,000 sf of usable space.

- *Faculty/Staff offices (10-12)*
- *Student workstations (10-12)*
- *Large conference room / space for hosting events*
- *Bathrooms*
- *Kitchenette with informal dining space*
- *Small meeting rooms*
- *Storage space*

3.2.2 SUSTAINABILITY CENTER

(From 07.15.21 Sustainability Center document. See Appendix for complete text.)

What it is:

- *The hub for sustainability activities and initiatives on campus.*
- *The first stop for prospective/current students, faculty, staff and general public interested in sustainability and getting involved*
- *Distinct concept areas in the building:*
  - *Workshop/conference/training space*
  - *Informal communal space*
  - *Focus professional staff space (offices/shared workspace)*
  - *Student work space (groups, stations, storage, collaboration areas)*
  - *Interpretive center to connect campus visitors to sustainability across the campus. There would be interactive displays.*
  - *Outdoor classroom*
- *Physical space, in relationship to the distinct areas:*
  - *Library: books, tool check-out, seeds, etc including examples of prior projects, written materials (books, articles, etc), tools (energy data loggers, etc.), H\hardcopy films*
  - *Lounge/informal space, touch point for visiting students, faculty and staff. promoting a community*

Student workspaces

Conference room, medium up to 10 people

Lecture Room, space for workshops/screenings/lectures

Gallery space

Staff workspaces (Offices)

Shared work space w/3 person conf space

Community touch point

Work Room/Storage; posters, pins, shirts, creating materials, general office machines

Kitchen: Place to store and wash durable dishes and utensils, Refrigerator & freezer, Small stove to cook on or prepare lunch food, Ample space for compost bucket and waste sorting

- *Focus for coordination and support of HEIF, Green Campus, Sustainability Committee, other relevant org's, Earth Week Every Week (Associated Students Committee)*
- *Hub for the Green Scene*
- *A place to showcase or make the Humboldt Sustainability Dashboard come to life*

What it manifests:

- *Works with campus partners to integrate sustainability into operations, goals and programming. Campus facilitators, outreach and training.*
- *Bridge between campus and community for sustainability/climate resilience activities and initiatives*

  Facilitate interdisciplinary applied research for the City of Arcata and other community partners

  A touch point for collaborating on grants
- *Provides experiential learning and leadership opportunities for students outside of the classroom - Student Leadership Institute for Climate Resilience (SLICR), EcoReps, volunteer, intern, paid positions...*
- *Facilitates professional development opportunities for faculty and staff in sustainability*
- *Coordinates Earth Week or annual sustainability/resilience summit*
- *Opportunities to host networking and social events where food could be served (less formal) or screenings could happen (films or keynote speakers)*
- *A place to cultivate ideas to integrate sustainability from the classroom to the campus to the community (nested model)*
- *A place to advertise & advise on sustainability minors & certificates*
- *A place to learn about sustainability designated courses, internships*
- *Homebase for the Sustainability Learning Community (PBLC)*
- *Space to host field trips for K-12 students; teacher workshops*

3.3 SPACE PROGRAM

3.3.1 PROCESS

During the programming process, adjustments to the initial program narratives were made in Working Group Meetings and reviewed and approved with the Stakeholder Working Group. An Overall Space Summary and Detailed Space List have been prepared and are included on the following pages.

3.3.2 DEFINITIONS

The space list uses the following terms or categories to describe the space requirements:

- Net or Assignable Area (ASF). The area of each space, as measured from interior wall to interior wall. Circulation space to or from the space is excluded, except at open workstations and enclosed offices that are part of a larger office environment or office suite.
- Building Gross Area (GSF). The total area of the building, including all primary circulation routes, shared vertical circulation, exterior walls and all mechanical shafts, plumbing chases, and telecommunications and electrical support spaces.

3.3.3 SPACE PROGRAM SUMMARY

The Space Program is organized around the following primary categories:

- Energy Research
- Sustainability
- Shared Resource Spaces

Figure 3.3.3.1 - Space Program Summary

Department	Functional Category				Program		
	Research/Teach Lab - 200	Classroom - 100	Study - 400	Office Facilities - 300	Total ASF	% ASF	Total Stations
Energy Research	6,875			1,320	8,195	63%	
Sustainability Center				1100	1,100	8%	
Shared		1,980	495	1275	3,750	29%	49
Function Subtotal	6,875	1,980	495	3,695			
% ASF	53%	15%	4%	28%			
Total Area / Assignable Square Feet (ASF)					13,045		
Efficiency Factor					60.00%		
Total Area / Gross Square Feet (GSF)					21,742		

3.3.4 DETAILED SPACE LIST

The Detailed Space List further segregates the primary organizational components into each of its functional space types (e.g. Teaching Lab, Laboratory Support, Research, Office, etc.) Within each sub-group the following have been identified:

- room name
- quantity of each room
- student stations per room
- student stations total based on quantity of rooms
- ASF of each room
- ASF total based on quantity of rooms
- Module quantity (where occurs)

Figure 3.3.4.1 - Detailed Space List

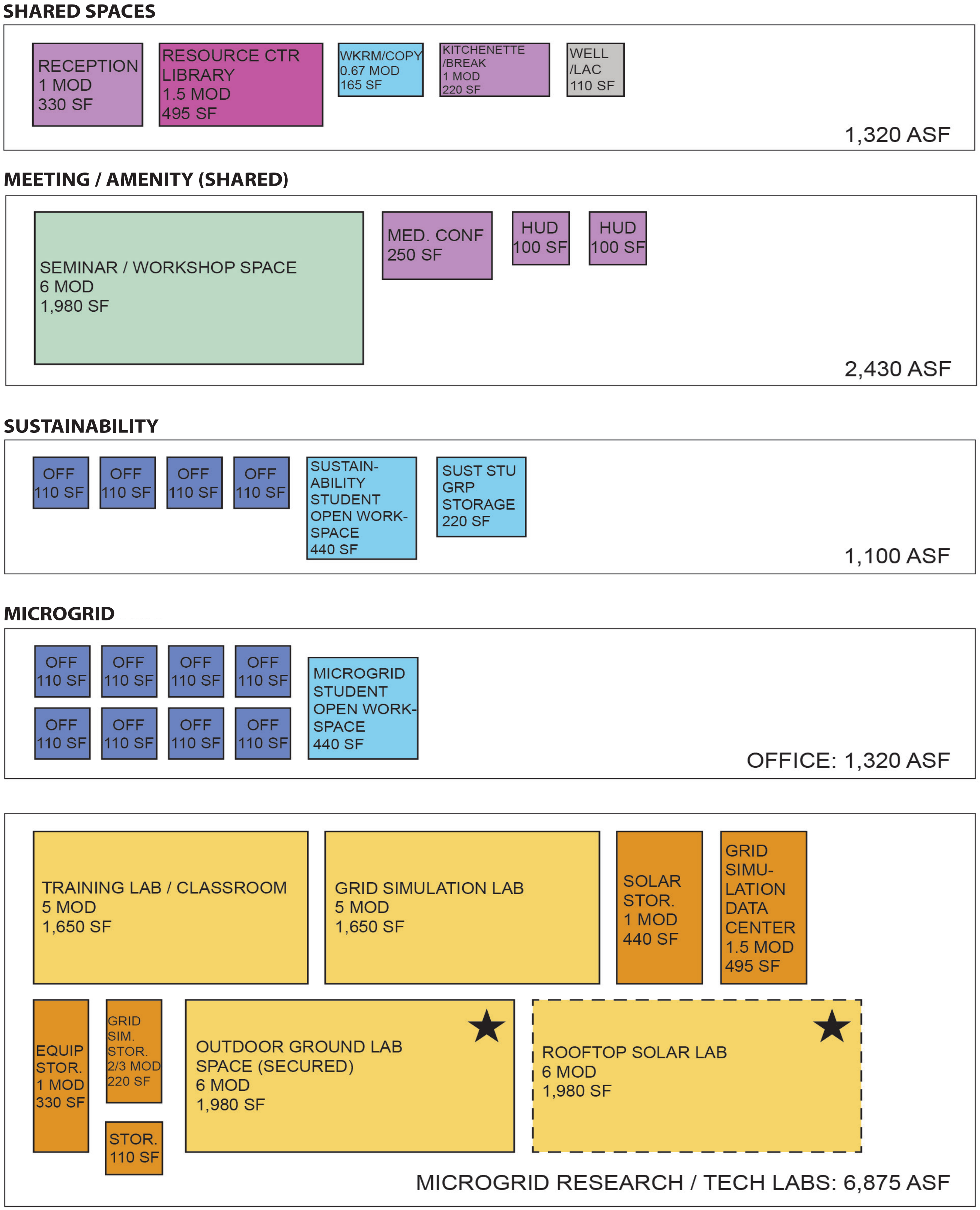
	Space Catagory	No.	Stations	Total Stations	FTE	ASF	# Modules / Space	Total # of Modules	Total Modular ASF	Total GSF
ENERGY RESEARCH & SUSTAINABILITY CENTER				**49**		**11,895**		**45**	**13,045**	**21,742**
SHARED SPACES									**3,750**	**6,250**
Shared Resources								**4.67**	**1,320**	
Reception	Office/Other	1				330	1	1	330	
Resource Center/Library	Study Room	1				495	1.50	1.50	495	
Work Room - Copier/Storage	Office Service	1				165	0.50	0.50	165	
Kitchenette/Breakroom	Office Service	1				220	0.67	0.67	220	
Wellness / Lactation	Office Service	1				110	1	1	110	
Meeting/Assembly (Shared)								**12**	**2,430**	
Seminar/Workshop Space	Seminar	1	49	49		2,000	6	6	1,980	
Medium Conference Room	Conference	1				250	2.27	2.27	250	
Huddle Room	Conference	2				100	1.82	3.64	200	
SUSTAINABILITY									**1,100**	**1,833**
Sustainability								**3.3**	**1,100**	
Sustainability Staff Offices	Office/Admin	4				110	0.3	1.3	440	
Sustainability Student Open Workspace	Office/Admin	1				440	1.3	1.3	440	
Storage Sustainability/Student Groups	Office Service	1				250	0.7	0.7	220	
MICROGRID								**25**	**8,195**	**13,658**
Microgrid Offices								**4**	**1,320**	
Microgrid Staff Offices	Office/Admin	8				110	0.3	2.7	880	
Microgrid Student Open Workspace	Office/Admin	1				440	1.3	1.3	440	
Microgrid Research/Instruction Labs								**18.83**	**6,215**	
Training Lab/Classroom	Resch/Teach Lab	1				1,650	5.0	5.0	1,650	
Grid Simulation Lab	Resch/Teach Lab	1				1,650	5.0	5.0	1,650	
Grid Simulation Data Center	Resch/Teach Lab	1				495	1.5	1.5	495	
Outdoor Lab Space	Resch/Teach Lab	1				1,980	6.0	6.0	1,980	
Outdoor Solar Lab	Resch/Teach Lab	1				See note			See note	
Solar Storage and Staging/Work Area	Resech Lab Service	1				440	1.3	1.3	440	
Instructional and Research Support								**2.03**	**660**	
Equipment Storage	Storage	1				330	1.0	1.0	330	
Grid Sim Storage	Storage	1				220	0.7	0.7	220	
Storage	Storage	1				110	0.3	0.3	110	

NOTE: The outdoor solar lab is an exterior zone for solar panel testing estimated as requiring 1,980 sf. See the guideplate for required infrastructure. However, as this space is flexible and not enclosed, it is not included in the ASF totalss.

3.3.5 GRAPHIC PROGRAM

The following is a graphic depiction of the Program. Each shape indicates the size and number of each area of assignable square feet included in the program. The size of each space shown is proportional to the amount of area it occupies relative to the other areas in the building. For clarity, the graphic program is organized by the major program areas and color-coded to correspond to the Space Program as well as the planning test-fit in Section 4.

Figure 3.3.5.1 - Graphic Program



3.4 ADJACENCY WORKSHOP: "THE PERFECT DIAGRAM"

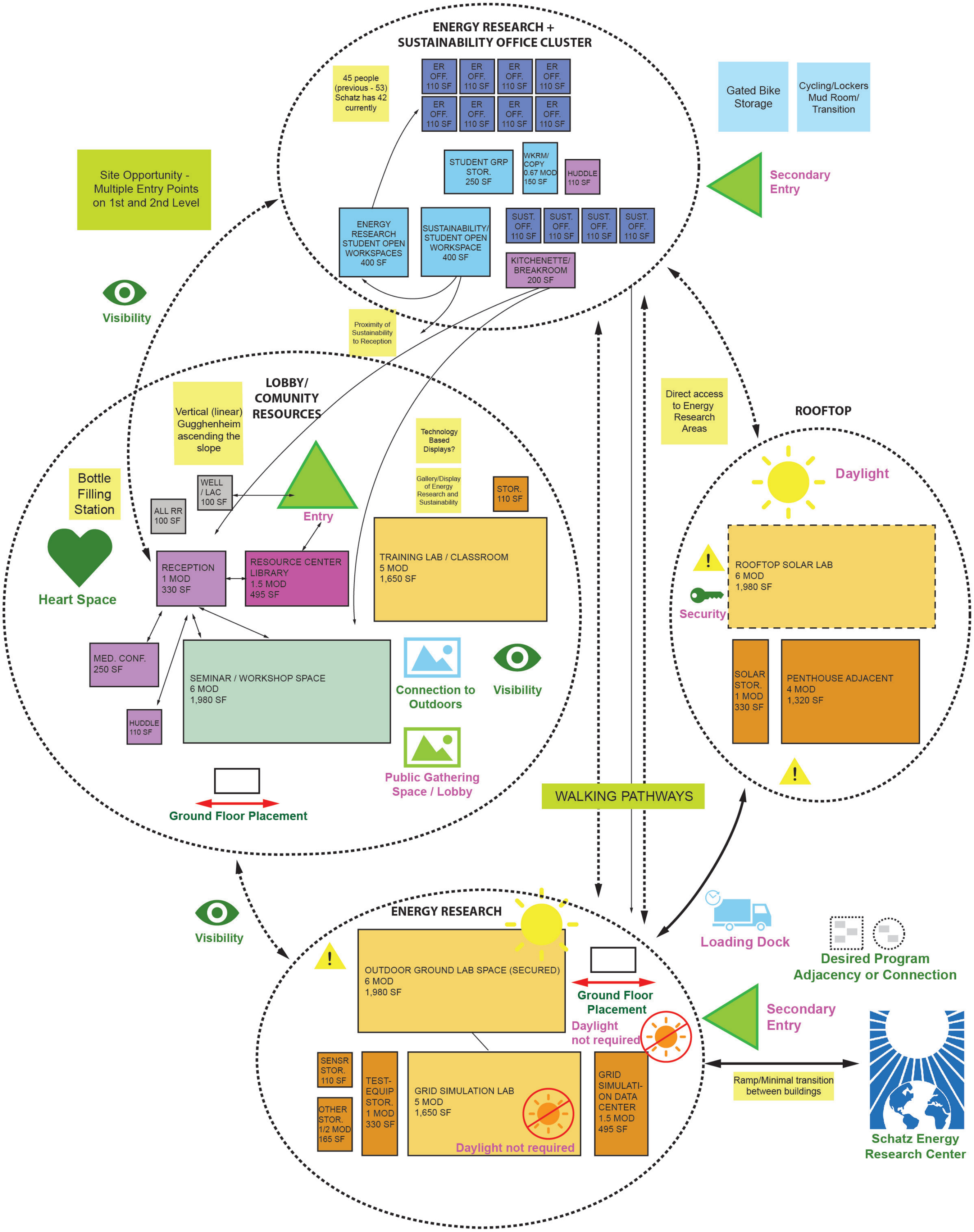
PURPOSE

The following workshop exercise was conducted to have working group stakeholders describe the key functions that would be conducted amongst the program spaces identified in an idealized "diagram" without the constraints of a physical reality. Key considerations of this exercise encouraged stakeholders to have a "blue sky" ideation mindset with "Yes, and.." being the prompt to consider these factors; arrival sequence for different user types and purpose, primary and secondary adjacencies, direct access, indoor/outdoor relationships, presence and identity, acoustical separations, daylighting/orientation, transparency or privacy, security, loading, security, amenities and visibility. The exercises were conducted as an iterative process with the workshop and follow up meetings to validate the feasibility team's understanding of the desired adjacencies.

SUMMARY OF PRIORITIES

- Shared Collaboration and Resources Spaces can create a welcoming presence for the new center. A prominent entryway that has a presence on campus to direct visitors, staff and students to the more public facing functions first. The Office of Sustainability would like to be adjacent to the shared collaboration spaces and resource library to extend a welcoming presence to the reception experience.
- The Microgrid Training Lab / Classroom is adjacent to the shared collaboration and resource spaces, but desires adjacency and visibility with the Microgrid research labs, which need to be more secured with controlled access because of the safety related to these lab spaces.
- The workspaces including offices for Microgrid Energy Research and Office of Sustainability with student support workstations, and related storage can be collocated to support collegial collaboration and foster learning community.
- The Microgrid research labs and support spaces required maximum solar access and orientation for the outdoor labs and a secondary entryway with ground floor access to load/unload research equipment easily. An outdoor Solar Lab at a roof terrace level should be considered with accessibility to the outdoor ground and grid simulation lab spaces without an elevator to move equipment. There is also a desired adjacency of Microgrid research labs to the Schatz Energy Research Center for collaborative research efforts.

Figure 3.4.1 - Programmatic Adjacency Diagram



3.5 ROOM DATA SUMMARY MATRIX

The Room Data Matrix gives an overview of the functional and utility requirements for each of the typical room types described in the Space Program. Similar to the Space Program, the matrix is categorized by department.

The Room Data Summary Matrix was prepared initially by the design team based on experience with each room type from similar environmental systems buildings in the CPH system. It was then refined after being reviewed by the user groups and incorporating their comments.

The matrix tracks the following functional and utility requirements:

- Room Air
- Services
- Specialty Gases
- Power
- Communications
- Temperature

Figure 3.5.1 - Room Data Matrix

Room Data Matrix

- □ Required for space
- ■ Requested - To be discussed at time of Design-Build Project
- --- Not-Applicable

Room name	Room Air			Services										Power								Communications						Environmental			
	100% Exhausted	AC Rate Occupied (Minimum)	AC Rate Unoccupied (Minimum)	Safety Shower	Eye Wash	Hot & Cold (H/C) or Cold (C)	RO/DI Water	Process Cooling Water (CHWS&R)	House Vaccum (LV)	Compressed Air (15-30psi with Regulator) CA	Compressed Air (100psi with Regulator) CA	Specialty Gas	Medium Pressure Steam for Autoclave	120 V	120 V, Standby to Microgrid generator	208 V, 1ph	208 V, 1ph, Standby to Microgrid generator	208 V, 3ph	480 V	Ground	Dedicated Circuit	Fiber Optic	Video/ Cable	Data Connection	Audio System	Projection / Monitors	Wi-Fi	Required 24/7/365 HVAC	Temp - Winter (min.)	Temp - Summer (max.)	Relative Humidty (min)
Training Lab / Classroom	---	6	3	---	---	---	---	---	---	---	---	---	---	□	□	□	□	□	□	□	□	□	□	□	---	□	□	□	68°	75°	30%
Grid Simulation Lab	---	6	3	---	---	---	---	---	---	---	---	---	---	□	□	□	□	□	□	□	□	□	□	□	---	□	□	□	68°	75°	30%
Grid Simulation Data Center	---	6	3	---	---	---	---	---	---	---	---	---	---	□	□	□	□	□	□	□	□	□	□	□	---	□	□	□	68°	75°	30%
Out Door Test Yard	---	---	---	---	---	---	---	---	---	---	---	---	---	□	□	□	□	□	□	□	□	□	---	□	---	---	□	---	---	---	---
Exterior Solar Lab	---	---	---	---	---	□	---	---	---	---	---	---	---	□	□	□	□	□	□	□	□	□	---	□	---	---	□	---	---	---	---
Solar Storage	---	---	---	---	---	---	---	---	---	---	---	---	---	□	---	---	---	---	---	---	---	---	---	□	---	---	□	□	68°	75°	30%
Test Equip Storage	---	---	---	---	---	---	---	---	---	---	---	---	---	□	---	---	---	---	---	---	---	---	---	□	---	---	□	□	68°	75°	30%
Sensor Library Storage	---	---	---	---	---	---	---	---	---	---	---	---	---	□	---	---	---	---	---	---	---	---	---	□	---	---	□	□	68°	75°	30%
Storage	---	---	---	---	---	---	---	---	---	---	---	---	---	□	---	---	---	---	---	---	---	---	---	□	---	---	□	□	68°	75°	30%
Reception	---	6	3	---	---	---	---	---	---	---	---	---	---	□	---	---	---	---	---	---	---	---	---	□	---	---	□	□	68°	75°	30%
Resource Center / Library	---	6	3	---	---	---	---	---	---	---	---	---	---	□	---	---	---	---	---	---	---	---	---	□	---	---	□	□	68°	75°	30%
Workroom - Copier / Storage	---	6	3	---	---	---	---	---	---	---	---	---	---	□	---	---	---	---	---	---	---	---	---	□	---	---	□	□	68°	75°	30%
Kitchenette / Breakroom	---	6	3	---	---	□	---	---	---	---	---	---	---	□	---	---	---	---	---	---	---	---	---	□	---	---	□	□	68°	75°	30%
Wellness / Lactation	---	6	3	---	---	□	---	---	---	---	---	---	---	□	---	---	---	---	---	---	---	---	---	□	---	---	□	□	68°	75°	30%
Seminar / Workshop space	---	6	3	---	---	---	---	---	---	---	---	---	---	□	---	---	---	---	---	---	---	---	□	□	---	□	□	□	68°	75°	30%
Medium Conference Room	---	6	3	---	---	---	---	---	---	---	---	---	---	□	---	---	---	---	---	---	---	---	□	□	---	□	□	□	68°	75°	30%
Huddle	---	6	3	---	---	---	---	---	---	---	---	---	---	□	---	---	---	---	---	---	---	---	□	□	---	□	□	□	68°	75°	30%
Shared Workspaces	---	6	3	---	---	---	---	---	---	---	---	---	---	□	---	---	---	---	---	---	---	---	---	□	---	---	□	□	68°	75°	30%
Staff Offices	---	6	3	---	---	---	---	---	---	---	---	---	---	□	---	---	---	---	---	---	---	---	---	□	---	---	□	□	68°	75°	30%
IDF	---	6	3	---	---	---	---	---	---	---	---	---	---	□	---	---	---	---	---	---	---	---	---	□	---	---	□	□	68°	75°	30%
MPOE / MDF	---	6	3	---	---	---	---	---	---	---	---	---	---	□	---	---	---	---	---	---	---	---	---	□	---	---	□	□	68°	75°	30%
Restrooms	---	6	3	---	---	□	---	---	---	---	---	---	---	□	---	---	---	---	---	---	---	---	---	□	---	---	□	□	68°	75°	30%

3.6 ROOM DATA SHEETS

A Room Data Sheet has been completed for most of the spaces identified in the Space Program. The Room Data Sheets are intended to be graphic representations of potential room layouts, including equipment, laboratory benches, office furniture, etc. Also indicated on each sheet are preferred overall room dimensions, shown to the inside face of each wall. Detailed room services, such as electrical and data outlets, are intentionally not shown at this time and will be developed during future design phases. These room diagrams are the basis for understanding the capacity of the space program as well as testing the program on the proposed site. They are not intended to be the final layout.

3.6.1 MICROGRID RESEARCH / INSTRUCTION / SUPPORT

1. GRID SIMULATION DATA CENTER
2. TRAINING LAB / CLASSROOM
3. GRID SIMULATION LAB
4. OUTDOOR TEST YARD
5. EXTERIOR SOLAR LAB
6. MISCELLANEOUS STORAGE ROOMS
7. SOLAR STORAGE

3.6.2 SHARED RESOURCE SPACES

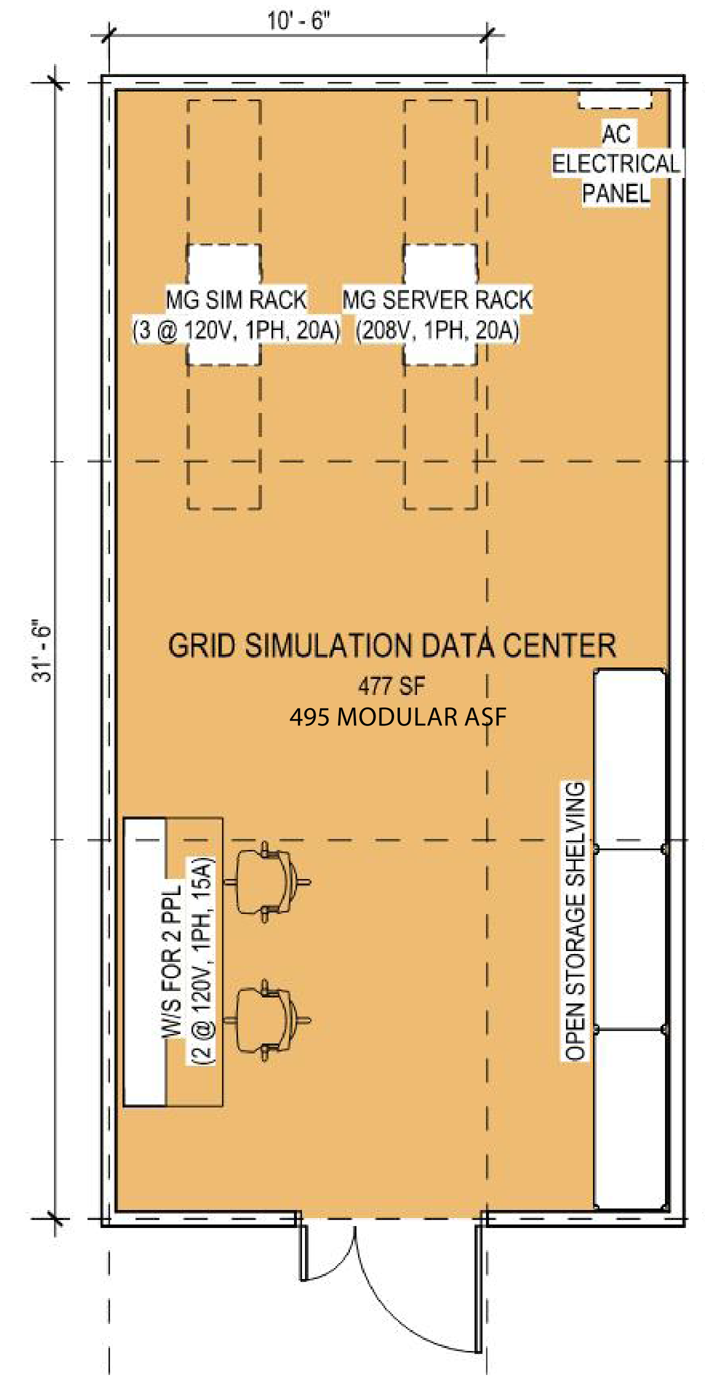
1. RECEPTION
2. RESOURCE CENTER / LIBRARY
3. WORKROOM
4. KITCHENETTE / BREAKROOM
5. WELLNESS / LACTATION

3.6.3 WORKSPACE

1. MICROGRID STUDENT OPEN WORKSPACE
2. SUSTAINABILITY STUDENT OPEN WORKSPACE
3. OFFICE

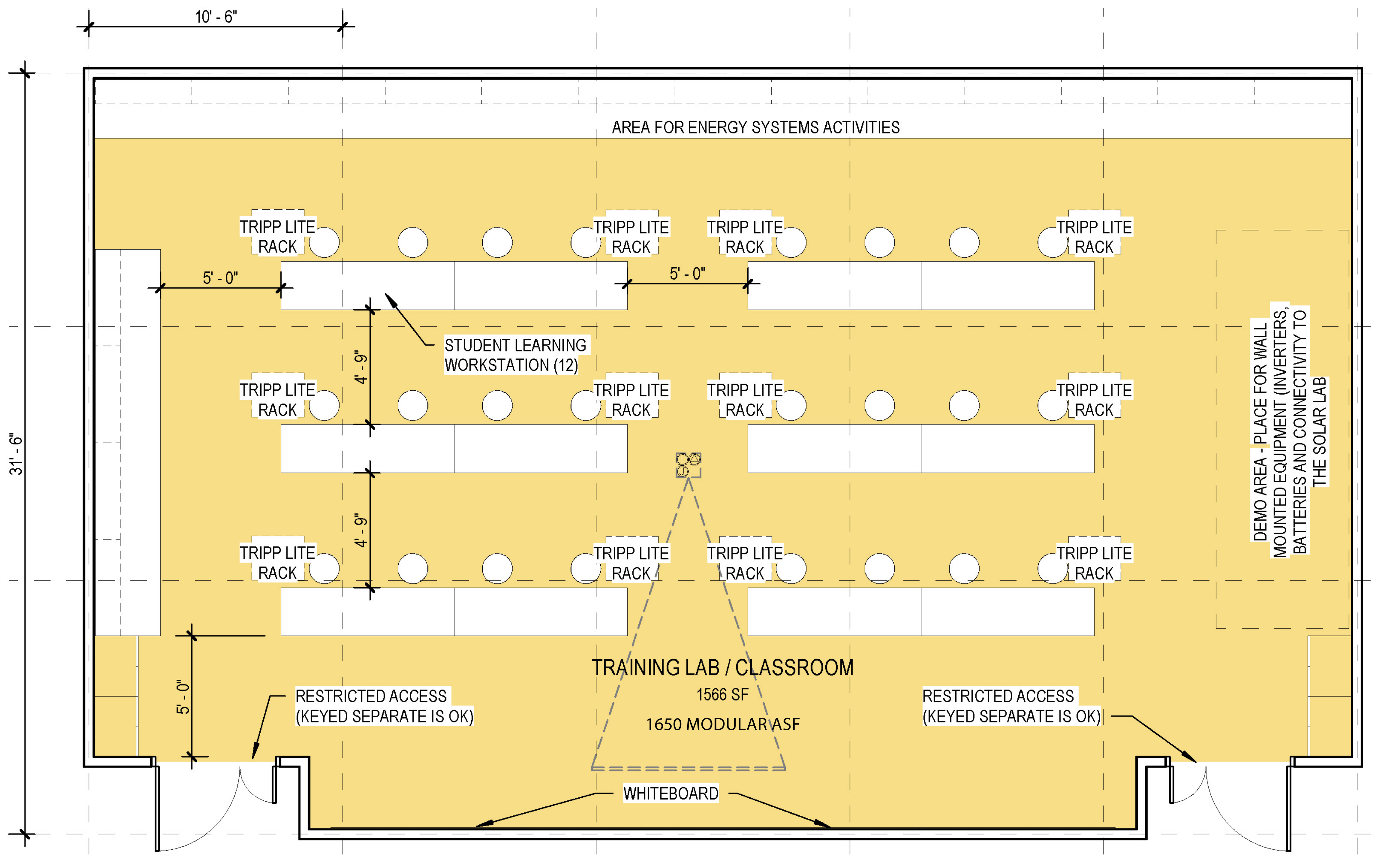
3.6.4 SHARED COLLABORATION SPACES

1. HUDDLE ROOM
2. MEDIUM CONFERENCE ROOM
3. SEMINAR / WORKSHOP SPACE



NOTES:
- TV NOT REQUIRED
- NEED TO RUN GPS ANTENNA TO EXTERIOR OF BUILDING. BUT ALSO COAXIAL CABLE TO CLASS ROOM, EXTERIOR SOLAR LAB, GRID SIMULATION AND TEST YARD

GRID SIMULATION DATA CENTER
GUIDE PLATE - ER+SC
Scale: 3/16" = 1'-0"



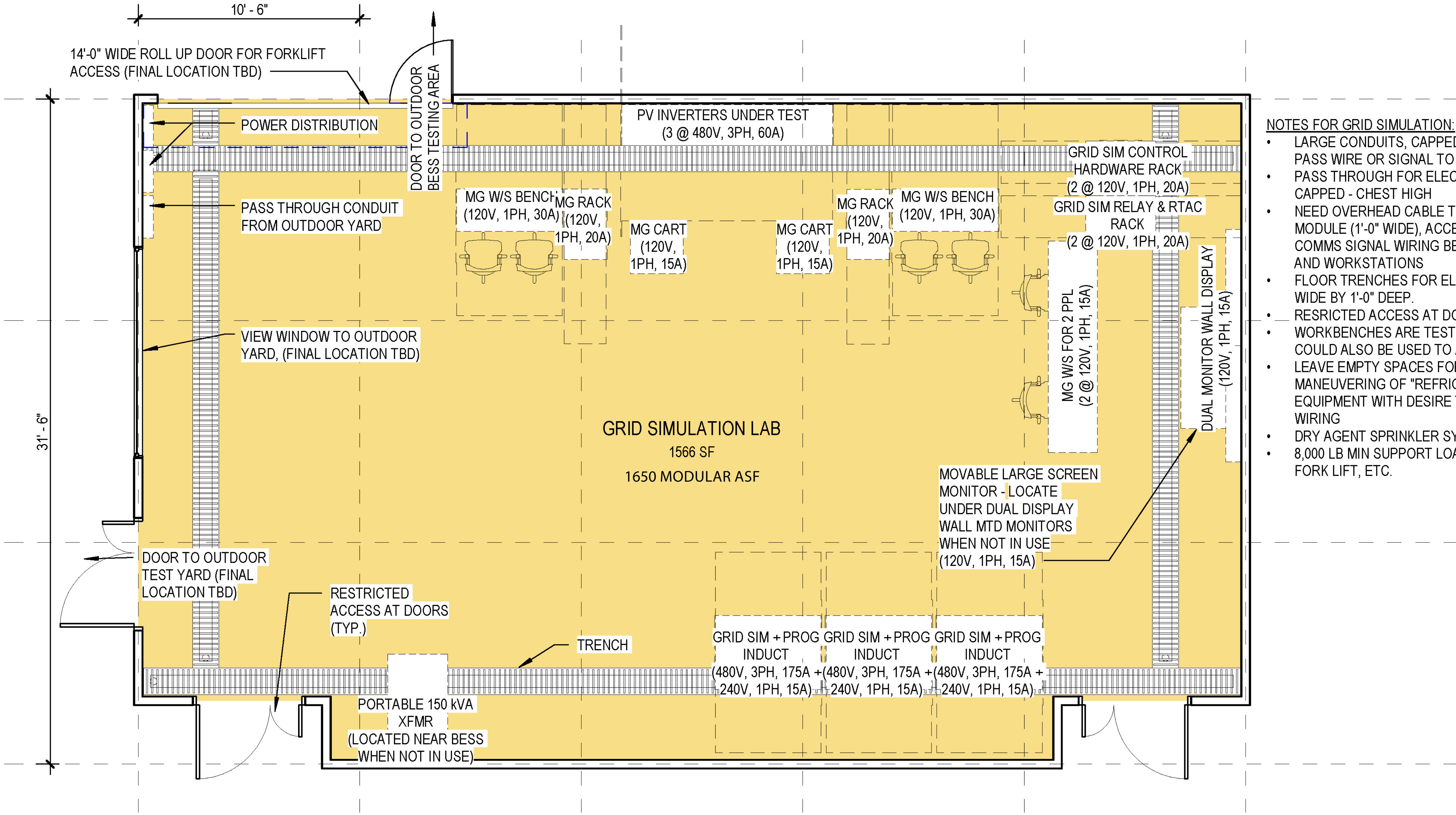
NOTES FOR TEACHING LAB / CLASSROOM:

- (24) STUDENT STATIONS, WORK IN GROUPS OF 2-4. STANDARD HEIGHT TABLE AND CHAIRS.
- FOCUS ON ENERGY SYSTEMS FUNDAMENTALS AND APPLIED DESIGN APPLICATIONS.
- BENCH SPACE FOR SCALED DOWN EXPERIMENTS (PROGRAM CONTROLS, SOLAR, BATTERIES, GRID/MICROGRID AUTOMATION PROTECTION, HEAT PUMP, ETC.)
- TV / PROJECTION FOR INSTRUCTION
- LOCKING CABINETRY AROUND PERIMETER FOR STORAGE OF SPECIALIZED EQUIPMENT, INSTRUMENTS AND TOOLS THAT CAN BE CHECKED OUT.
- UTILITIES AND SERVICES:
  1. SPACE ON WALL, ADJACENT TO OUTDOOR SOLAR LAB FOR MOUNTING INVERTERS
  2. CONDUIT AND WIRE CONNECTIONS TO OUTDOOR LAB:
     A. DC CONNECTION
        a. TO TEACHING / TRAINING LAB
        b. TO GRID SIMULATION LAB
        c. OUTDOOR TEST LAB LV SWITCHBOARD
     B. AC CONNECTION
        a. SAME LOCATIONS AS DC
  3. OVERHEAD CABLE TRAYS FOR POWER AND COMMS CABLES
- SMALL TRIPP LITE RACKS ON WHEELS ADJACENT TO EACH BENCH
- STUDENT BENCHES ARE ALL MOVABLE. NEED TO HANDLE UP TO 3226 WATTS. EACH BENCH NEEDS 208V, 1 PH, 30A POWER (IN FLOOR)
- BENCHES ARE GROUNDED, NON-CONDUCTIVE (120V SIGNALS).
- EQUIPMENT IS THE RACK AND RELAY TEST SET AT EACH BENCH
- RESTRICTED / KEYED ACCESS DOOR

TRAINING LAB / CLASSROOM

GUIDE PLATE - ER+SC

Scale: 3/16" = 1'-0"



NOTES FOR GRID SIMULATION:

- LARGE CONDUITS, CAPPED. RUN UP OR DOWN TO PASS WIRE OR SIGNAL TO OUTDOORS
- PASS THROUGH FOR ELECTRICAL/LARGE CONDUITS CAPPED - CHEST HIGH
- NEED OVERHEAD CABLE TRAY DISTRIBUTION ON MODULE (1'-0" WIDE), ACCESSIBLE AT ~8'-0" AFF. COMMS SIGNAL WIRING BETWEEN SIMULATOR RACKS AND WORKSTATIONS
- FLOOR TRENCHES FOR ELECTRICAL CABELING, 2'-0" WIDE BY 1'-0" DEEP.
- RESRICTED ACCESS AT DOORS
- WORKBENCHES ARE TESTING AND RESEARCH BUT COULD ALSO BE USED TO ACADEMIC WORK
- LEAVE EMPTY SPACES FOR WHEELING IN AND MANEUVERING OF "REFRIGERATOR" SIZED EQUIPMENT WITH DESIRE TO HOOK UP SIGNAL WIRING
- DRY AGENT SPRINKLER SYSTEM
- 8,000 LB MIN SUPPORT LOAD FOR TESLA BATTERY, FORK LIFT, ETC.

GRID SIMULATION LAB

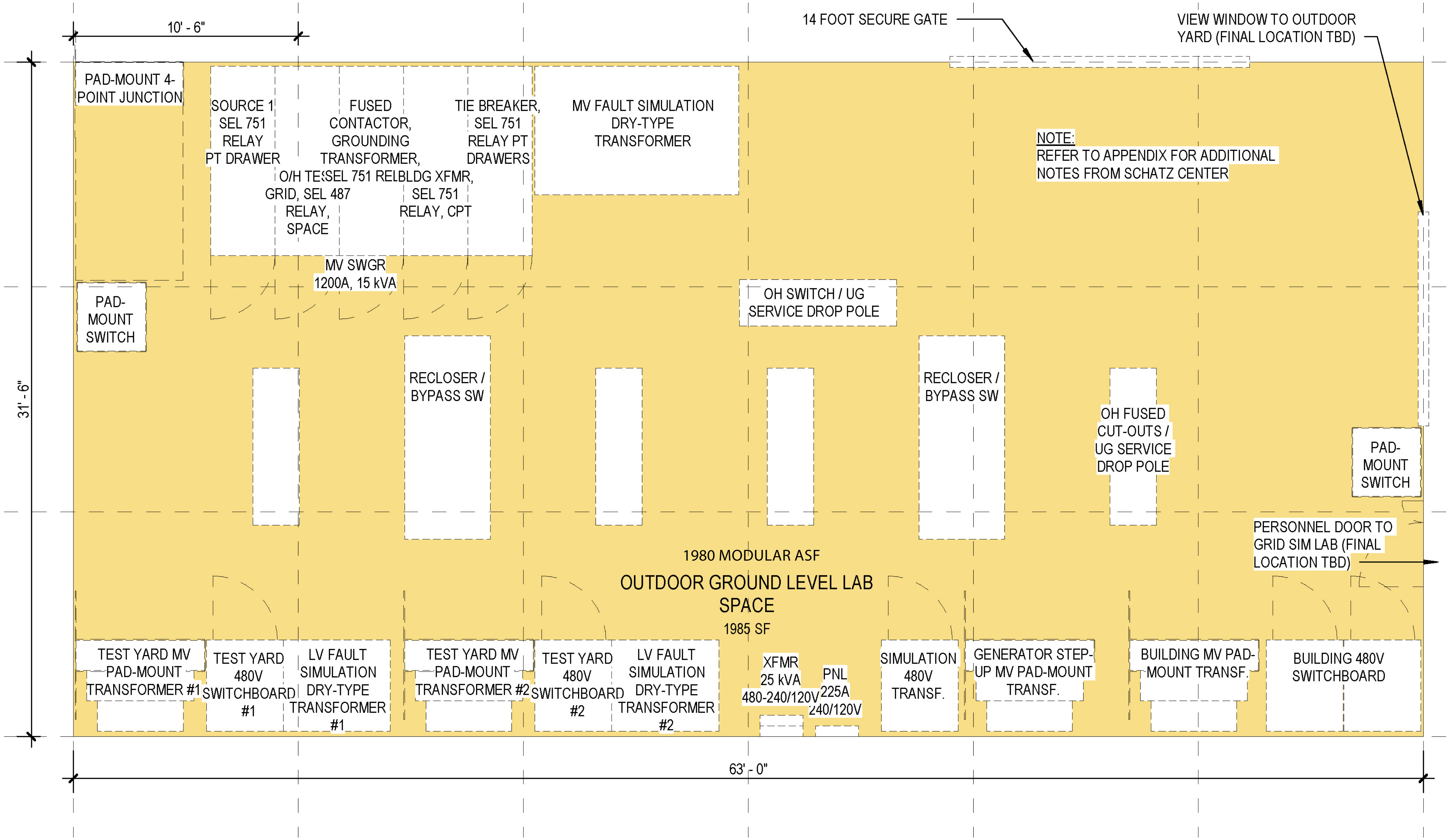
GUIDE PLATE - ER+SC

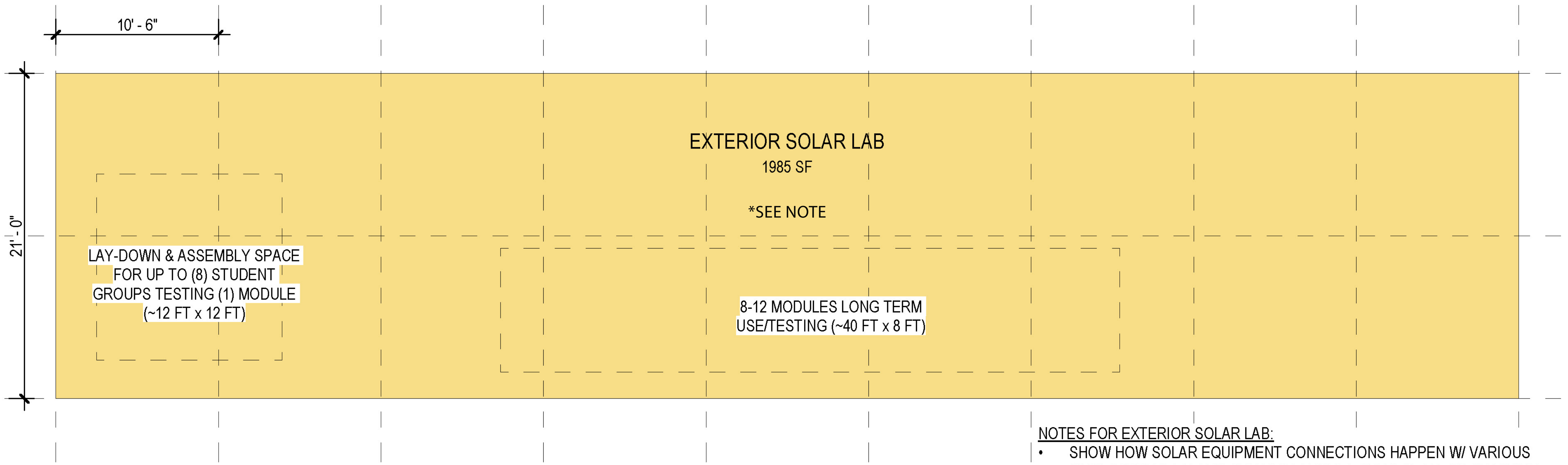
Scale: 3/16" = 1'-0"

OUTDOOR TEST YARD

GUIDE PLATE - ER+SC

Scale: 3/16" = 1'-0"





EXTERIOR SOLAR LAB

GUIDE PLATE - ER+SC

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

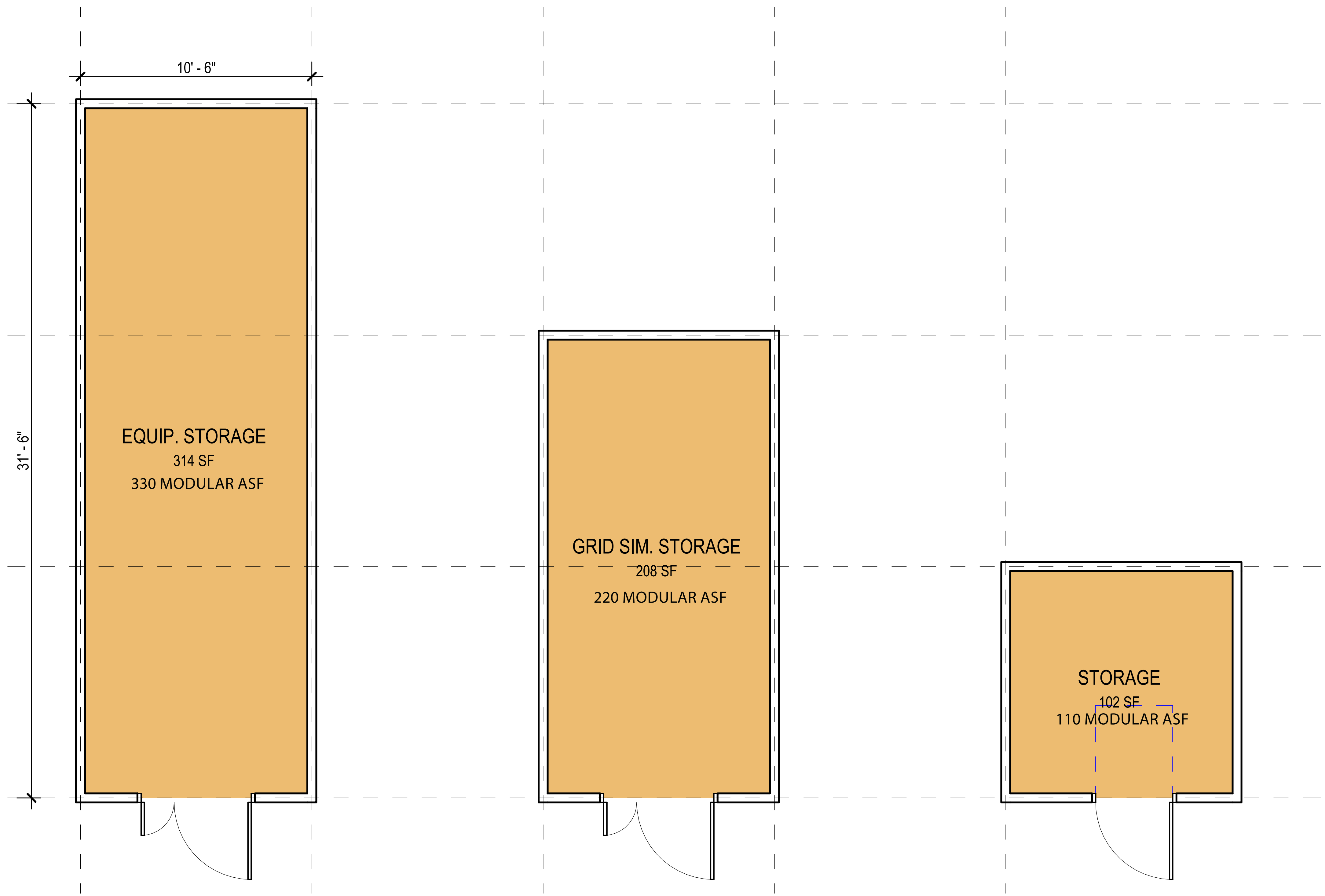
NOTES FOR EXTERIOR SOLAR LAB:

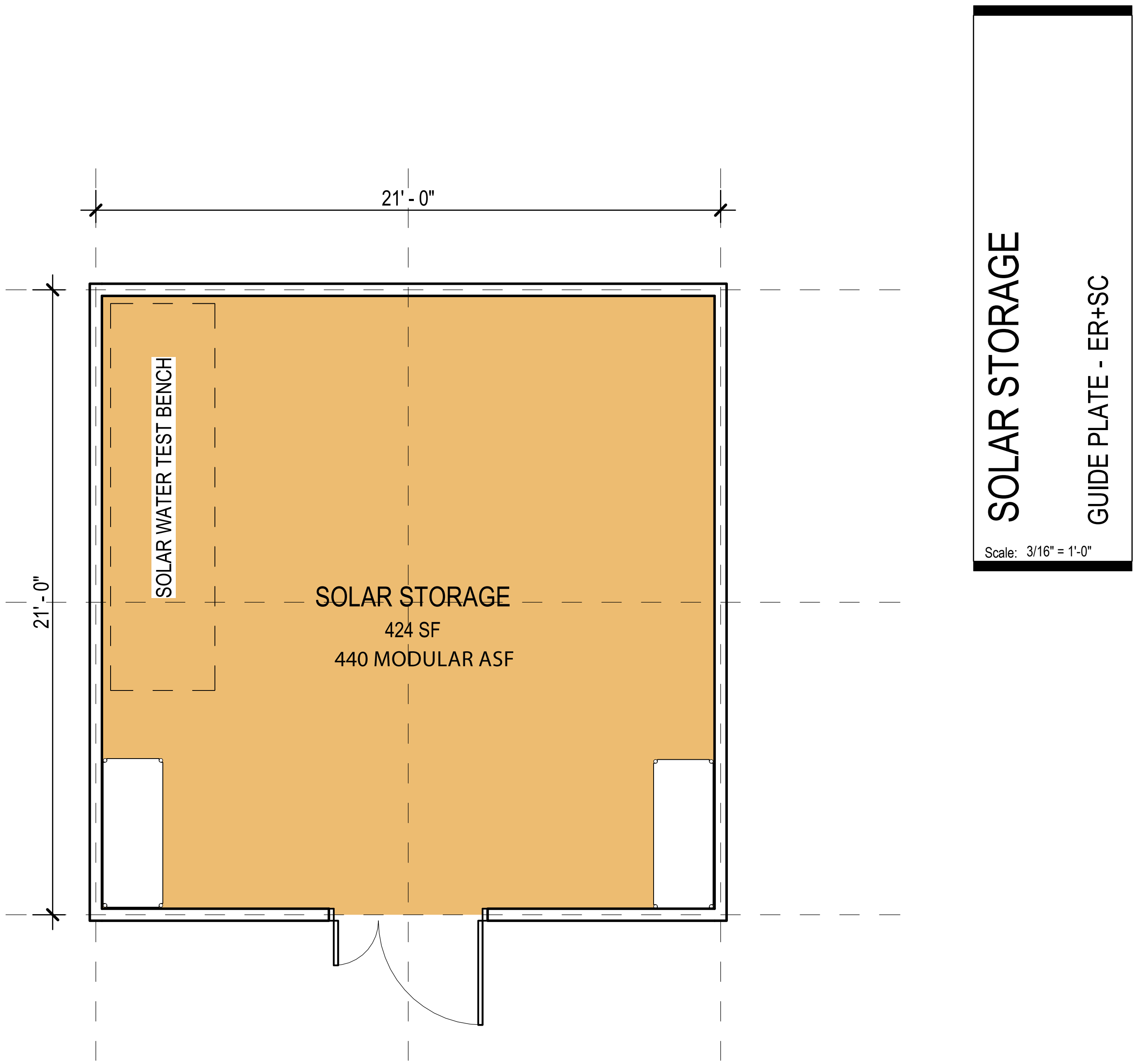
- SHOW HOW SOLAR EQUIPMENT CONNECTIONS HAPPEN W/ VARIOUS GRID-CONNECTED AND OFF-GRID ARCHITECTURES. ALL WITH POWER FLOW AND MONITORING.
- TESTING OF SOLAR MODULES
- SHORT AND LONG TERM TESTING OF SOLAR POWERED DEVICES AND/OR MODULES.
- PROVIDE CONDUIT CONNECTIVITY TO TRAINING / TEACHING LAB
- POSSIBLE TESTING OF SOLAR WATER HEATING SYSTEMS (120 GALLON TANK).
- PERMANENT WEATHER STATION
- UTILITIES AND SERVICES:
  1. HOSE BIBB (CONFIRM HOT AND COLD OR JUST COLD) AND DRAIN
  2. ETHERNET / IT CONNECTIONS
  3. CONDUIT AND WIRE CONNECTIONS TO OUTDOOR LAB:
     A. DC CONNECTION
        a. TO TEACHING / TRAINING LAB
        b. TO GRID SIMULATION LAB
        c. OUTDOOR TEST LAB LV SWITCHBOARD
     B. AC CONNECTION
        a. SAME LOCATIONS AS DC
  4. AC POWER
     A. STANDARD 120V, 1 PH, WEATHERPROOF RECEPTACLES, SPACED ~3 TO 4 FT ON CENTER AROUND PATIO
     B. 208V, 3 PH, 100A DISCONNECT FOR EXISTING SOLAR WATER PUMP TEST BENCH AND POSSIBLE FUTURE 3 PHASE SYSTEMS
- STAKEHOLDERS TO VERIFY ELECTRICAL CONNECTIVITY REQUIREMENTS BETWEEN SOLAR OUTDOORS LAB, GRID SIMULATION LAB AND CLASSROOM
- CLASSROOM AND EXTERIOR SOLAR LAB TO HAVE PHYSICAL ADJACENCY OR NEAR PROXIMITY
- EXTERIOR LAB REQUIRES UNSHADED SOUTHERN EXPOSURE

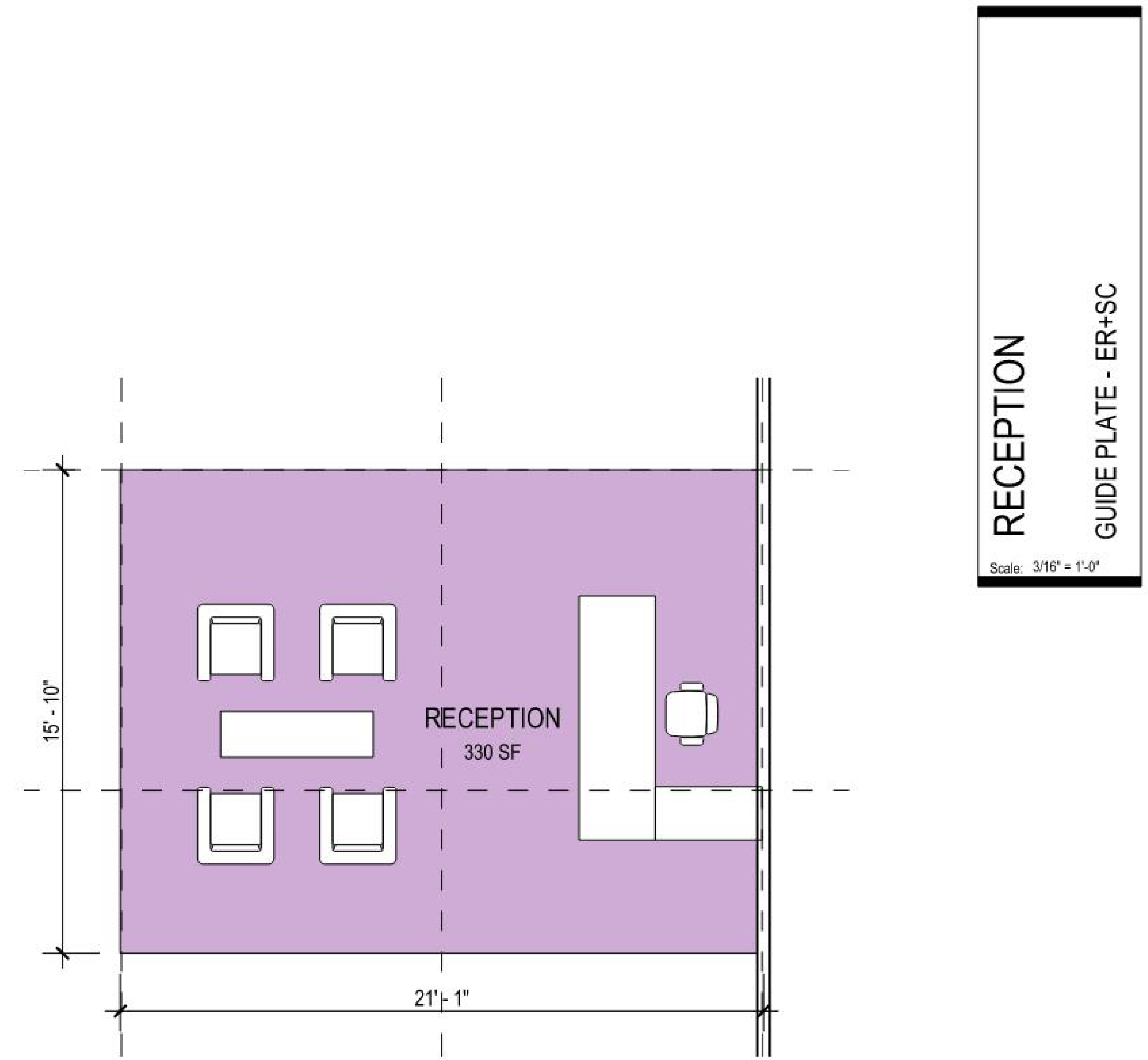
MISCELLANEOUS STORAGE ROOMS

GUIDE PLATE - ER+SC

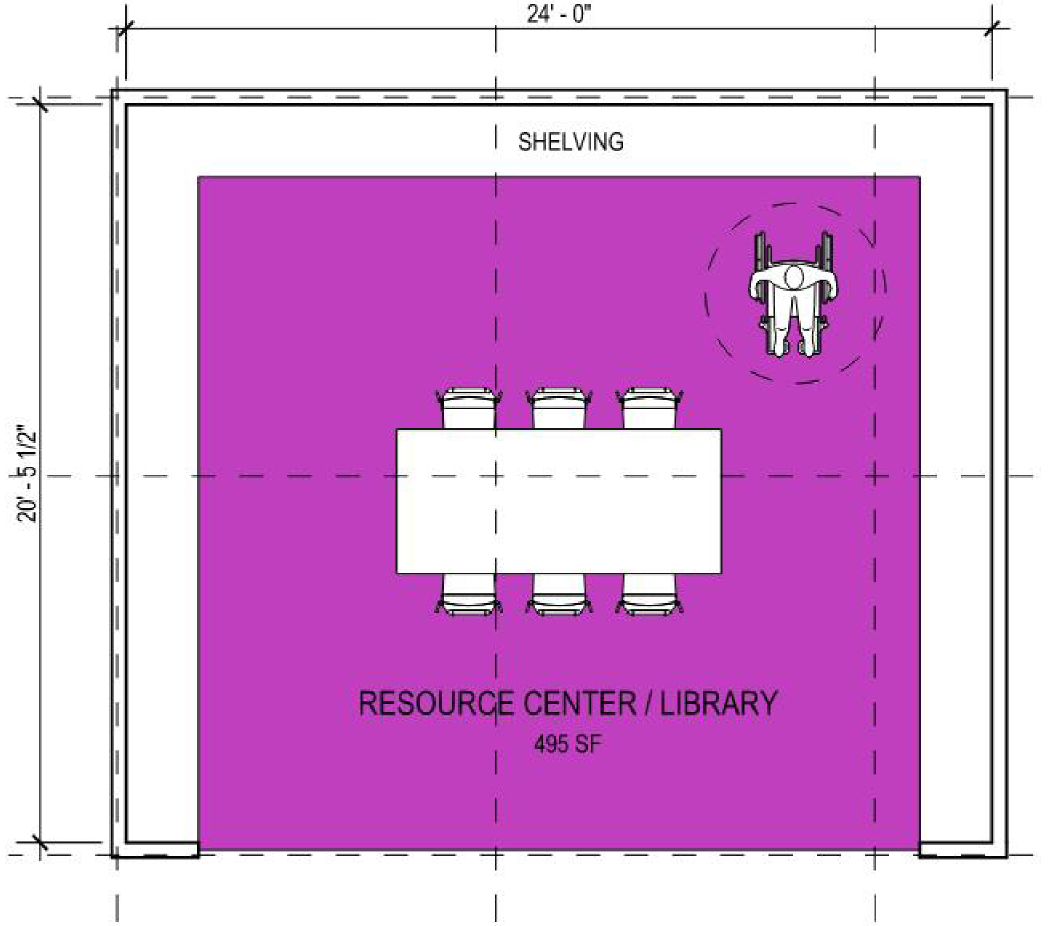
Scale: 3/16" = 1'-0"



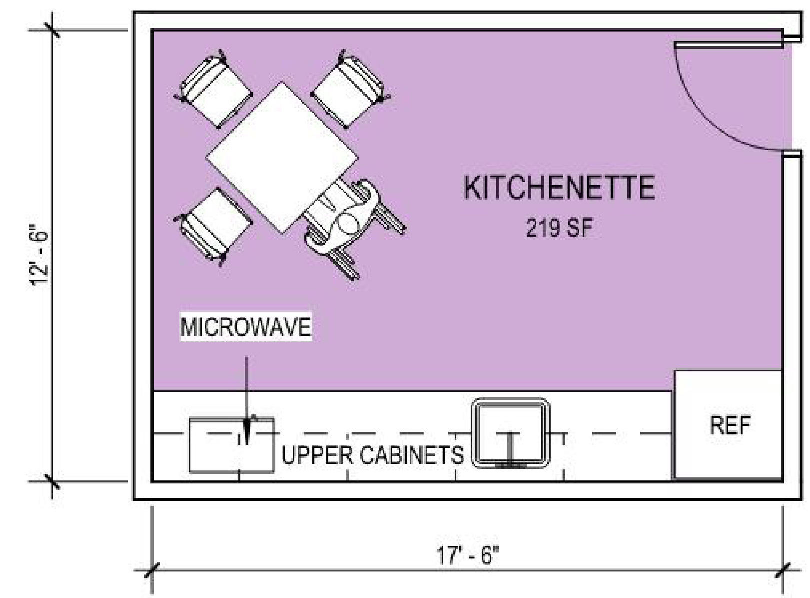




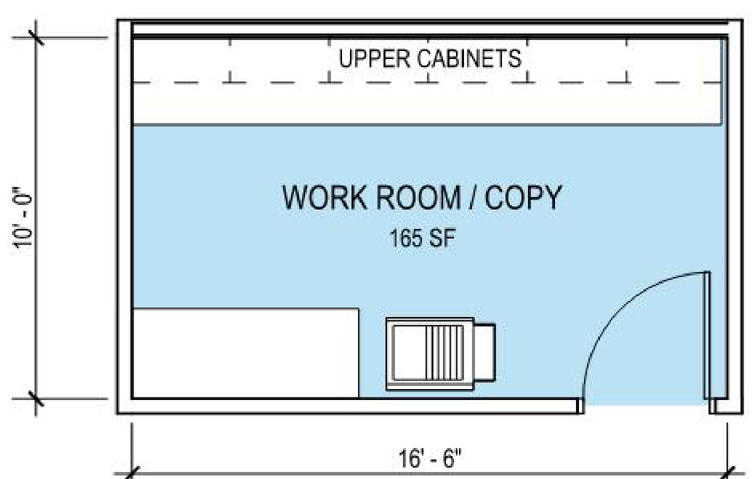
<u>NOTES FOR SOLAR STORAGE:</u>
STORAGE OF
- SOLAR MODULES
- INVERTERS AND OTHER ELECTRONIC COMPONENTS
- TESTING EQUIPMENT / INSTRUMENTATION
- SOLAR WATER PUMP TEST BENCH (MOBILE)



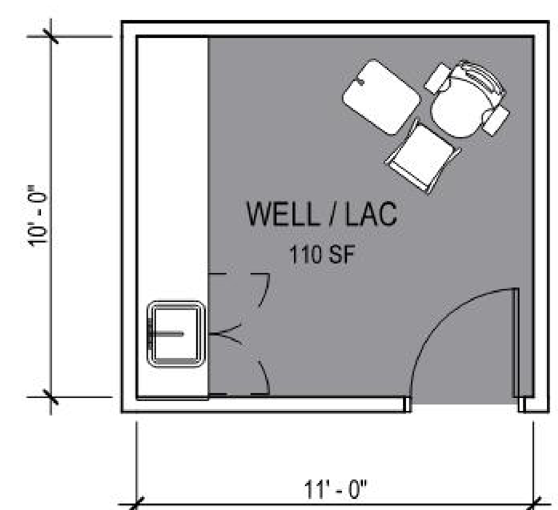
RESOURCE CENTER / LIBRARY
GUIDE PLATE - ER+SC
Scale: 3/16" = 1'-0"



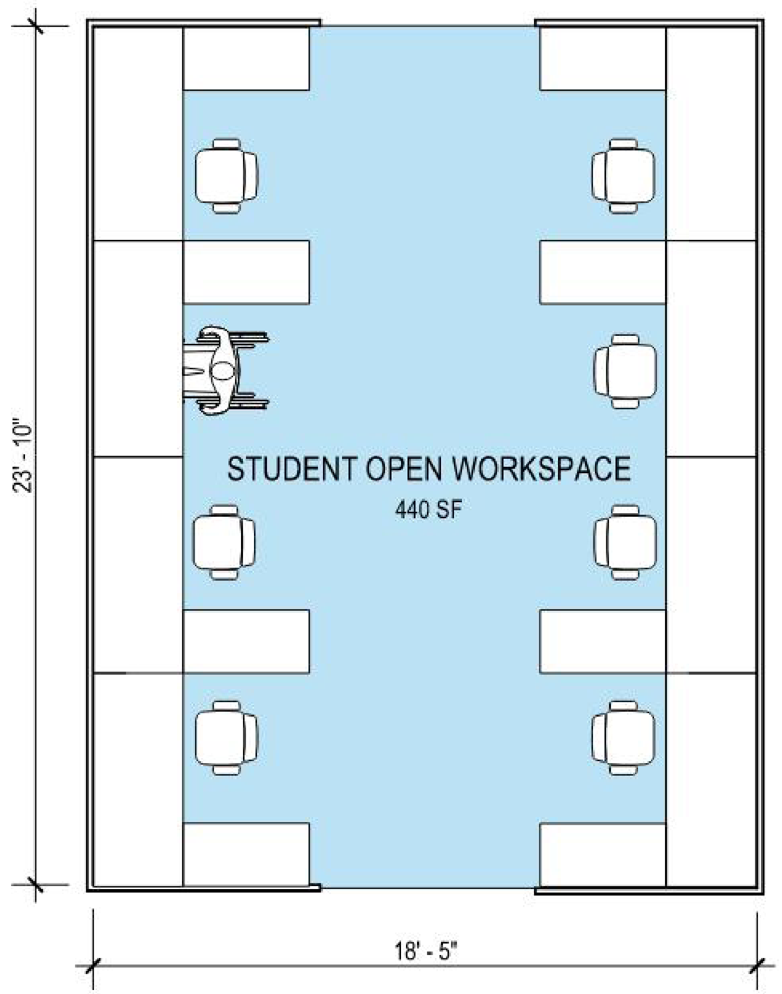
KITCHENETTE / BREAKROOM
GUIDE PLATE - ER+SC
Scale: 3/16" = 1'-0"



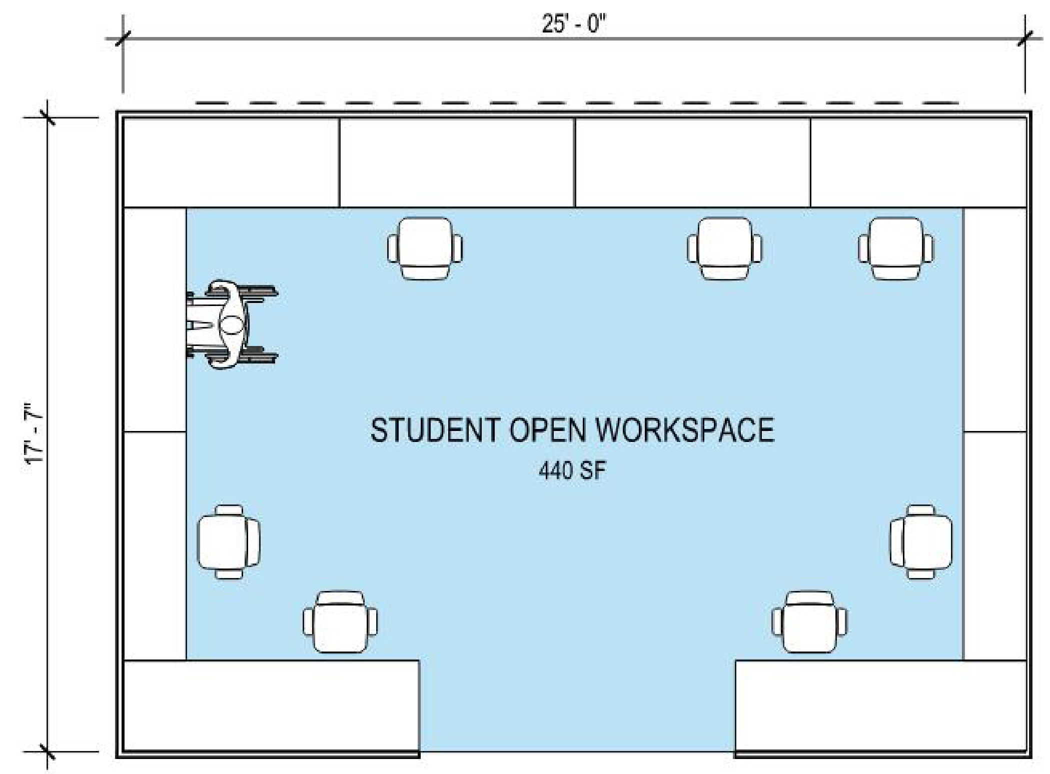
WORKROOM - COPIER / STORAGE
GUIDE PLATE - ER+SC
Scale: 3/16" = 1'-0"



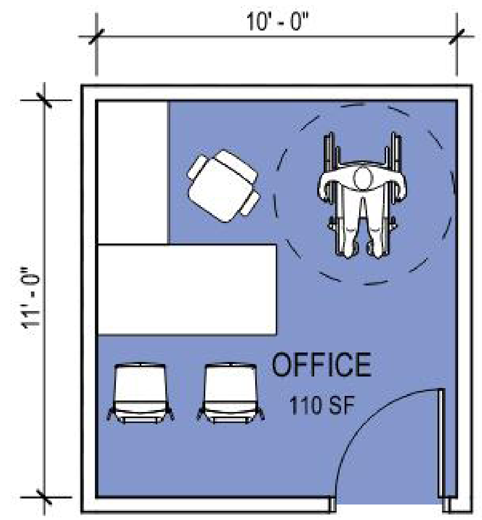
WELLNESS / LACTATION
GUIDE PLATE - ER+SC
Scale: 3/16" = 1'-0"



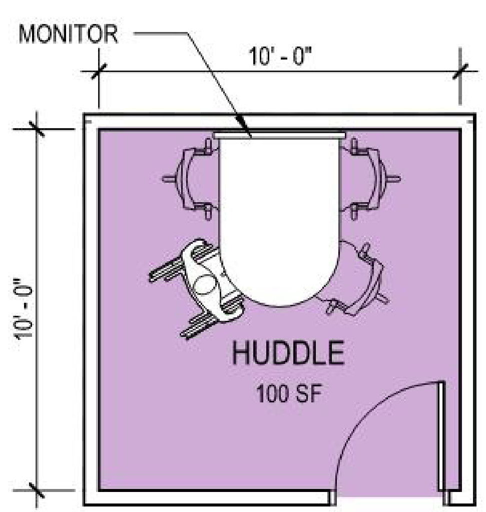
MICROGRID STUDENT OPEN WORKSPACE
GUIDE PLATE - ER+SC
Scale: 3/16" = 1'-0"



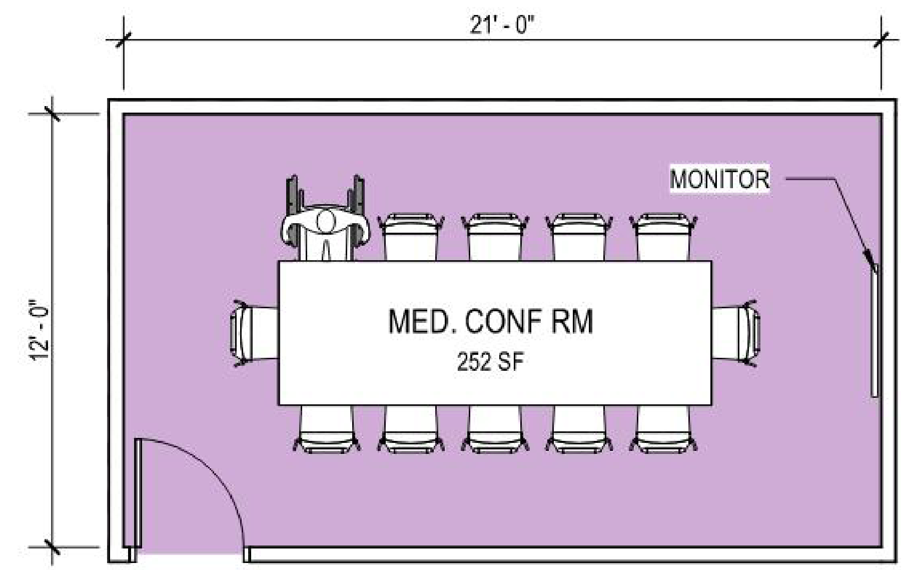
SUSTAINABILITY STUDENT OPEN WORKSPACE
GUIDE PLATE - ER+SC
Scale: 3/16" = 1'-0"



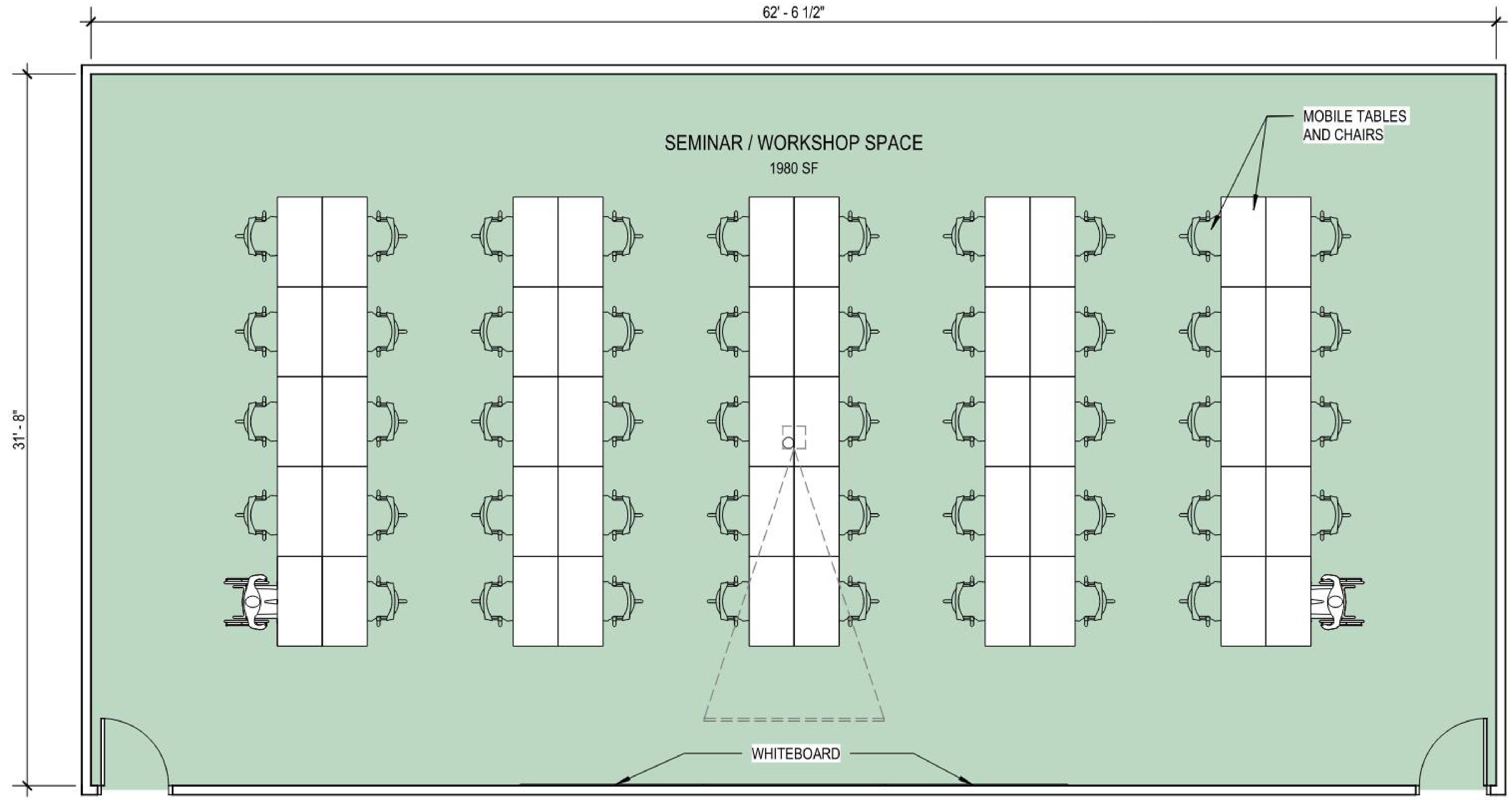
OFFICE
GUIDE PLATE - ER+SC
Scale: 3/16" = 1'-0"



HUDDLE ROOM
GUIDE PLATE - ER+SC
Scale: 3/16" = 1'-0"



MEDIUM CONFERENCE ROOM
GUIDE PLATE - ER+SC
Scale: 3/16" = 1'-0"



SEMINAR/WORKSHOP SPACE
GUIDE PLATE - ER+SC
Scale: 3/16" = 1'-0"

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04

SITE CONTEXT AND CONCEPT TEST FITS

4.1 SITE ANALYSIS

4.1.1 SITE LOCATION AND CONTEXT

The project site for the Energy Research and Sustainability Center is located east of B Street near the southern edge of the core campus. (Figure 4.1.1). The site is bounded to the south by a parking lot and to north by the Schatz Energy Research Center Building sited at the top of the hill. The west side of the site is defined by B Street, which connects the southern portion of the campus to the main core campus. The east side of the site is bounded by a steep secondary roadway that connects the southern parking lot to the Buck House located across from the service entry to the south that provides access to the Schatz Energy Research Center Building, Campus Center for Appropriate Technologies (CCAT) and the Behavioral & Social Sciences Building, located at the top of the hill and roadway.

The diagram below highlights the potential site boundary for the Energy Research and Sustainability Center Building. A setback of 100' from B Street is shown in white. The recommended setback is 100' as defined in the Campus Masterplan; however, if required a 75' setback may be considered.

Figure 4.1.1 - Energy Research and Sustainability Center Site Aerial Photograph

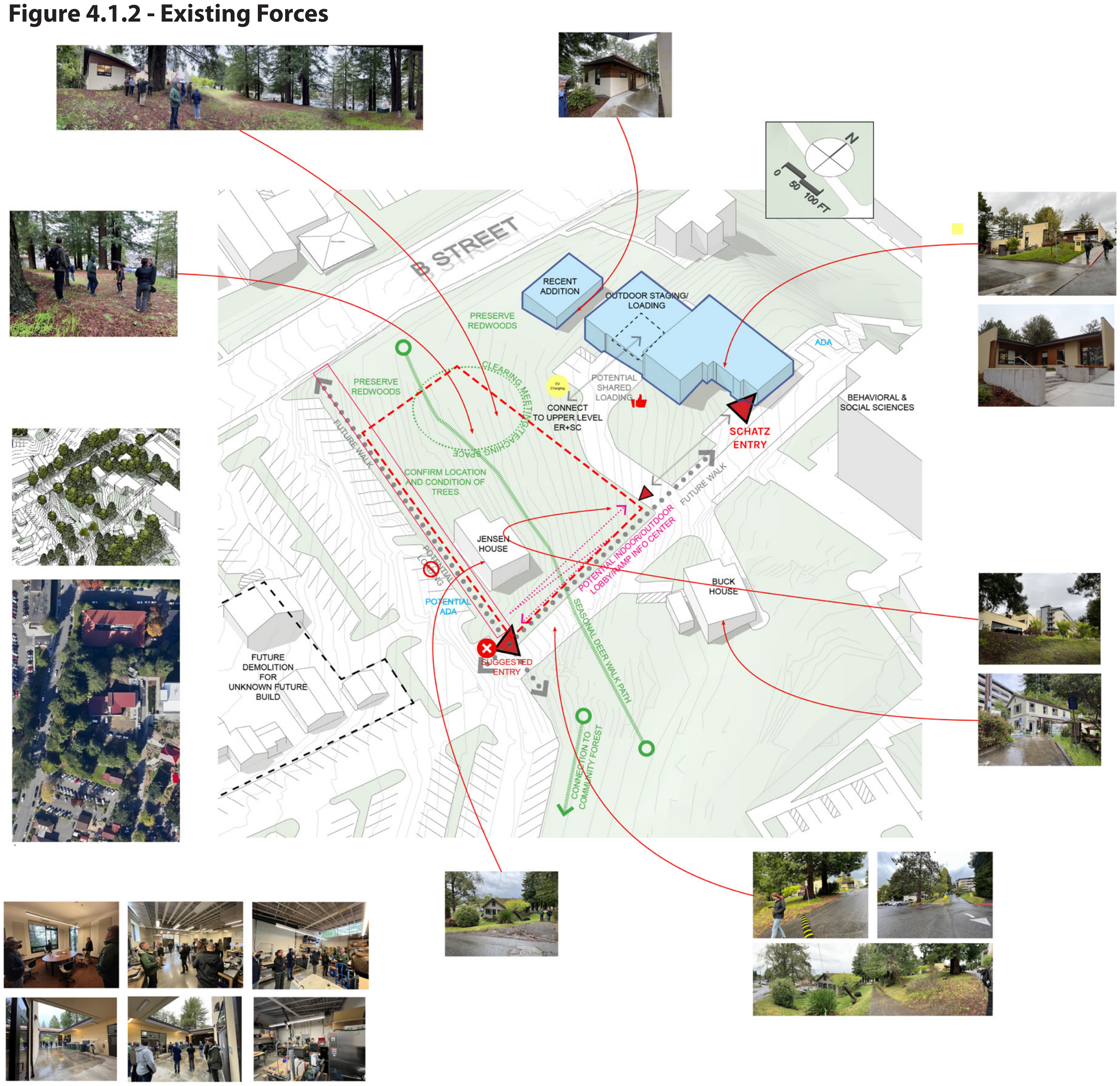
4.1.2 SITE OBSERVATIONS

The site is currently occupied by the Jensen House, which currently functions as part of the Campus's Children Center program and was originally constructed in 1950. Jensen House has an addition on the west side with its entry facing east towards Cluster Court. Immediately along the south edge is parking lot G14 which has an approximate 6% slope from east to west.

There is an existing small, paved area on the north side of the site that also provides one accessible parking space and a loading area for the Schatz Energy Research Center.

The building is shown to be closer to the south of the site to maximize working with the existing site conditions to minimize site excavation. There are formal hardscape pedestrian walks as well as informal paths across the site. The intent is to maintain the informal path in some form that travels from the southwest corner of the site to the northeast. The lowest level of the building was conceived as being raised above lot G14 with a sloped walkway leading from the parking lot to the lower-level entry point. There may need to be rework at the parking lot to accommodate accessible parking as required for the new facility.

Figure 4.1.2 - Existing Forces



4.1.3 CLIMATE FACTORS

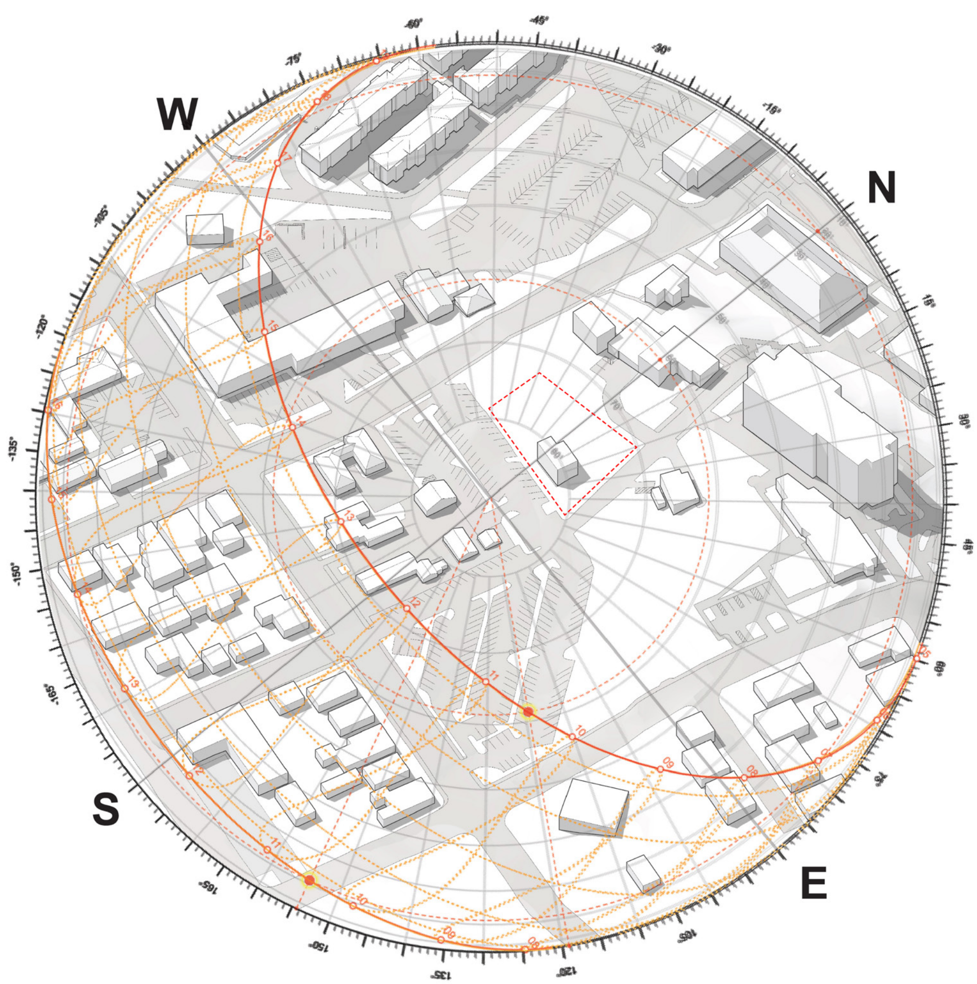
In a typical year, Arcata, California temperatures fall below 50F° for 181 days per year. Annual precipitation in Arcata is typically 44.1 inches per year (high in the US) and snow covers the ground 0 days per year or 0% of the year (the lowest in the US). It may be helpful to understand the yearly precipitation by imagining 9 straight days of moderate rain per year. The humidity in Arcata, California is below 60% for approximately 37 days or 10.1% of the year.

4.1.4 SITE SOLAR CONDITIONS

As shown in the solar diagram (Figure 4.1.4), the project site receives most of its sunlight from the south-southwest, along 14th Street. Given the current closed condition character of the site with its tree density and maturation, the site receives little sunlight from all sides. During the summer months, early morning and late afternoon sun will reach the northern portion of the site, however this area will receive little direct sun in the winter. During the winter, most of the sun will be concentrated along the southern edge of the site.

https://weatherspark.com/y/310/Average-Weather-in-Arcata-California-United-States-Year-Round#Sections-Sun

Figure 4.1.4 - Solar Diagram - Summer and Winter Solstice

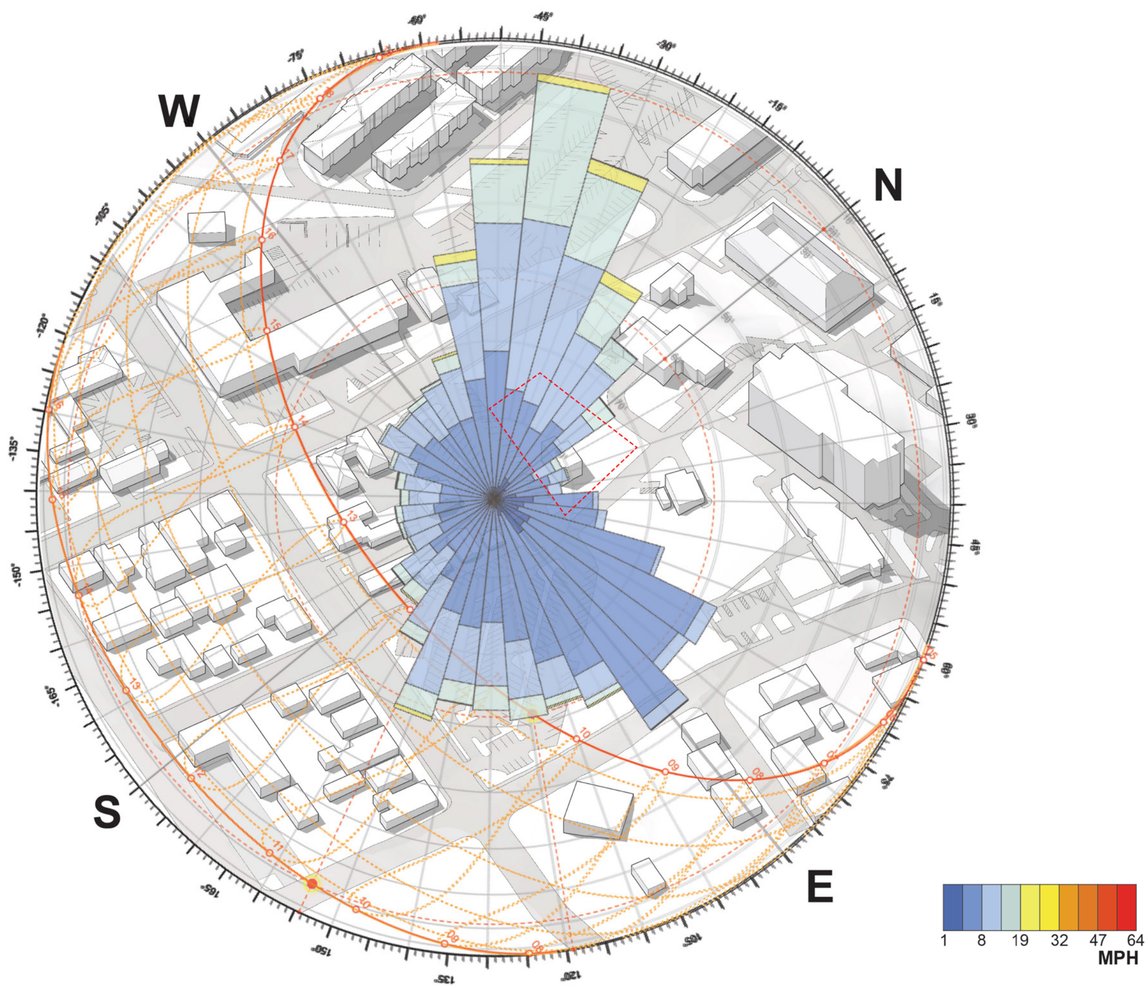


4.1.5 SITE WIND CONDITIONS

The wind analysis diagram (Figure 4.1.5) shows that the prevailing winds during both the summer and winter months are out of either the northwest or southeast. Given the hilly topography and more closed character of the campus adjacent to the site with its tree growth, there are multiple windbreaks to shelter the site from the prevailing winds.

https://weatherspark.com/y/310/Average-Weather-in-Arcata-California-United-States-Year-Round#Sections-Wind

Figure 4.1.5 - Annual Wind Diagram



4.1.6 SITE CONTEXT

The academic context surrounding the site is varied both in terms of program and character. Directly adjacent to the site is the Schatz Energy Center.

Figure 4.1.6 - Surrounding Context

- 036 Mary Warren House
- 037 Baiocchi House
- 038 Walter Warren House
- 039 Toddler Center
- 040 Natural Resources
- 040A Schatz Energy Research Center
- 046 Facilities Management
- 048 Hazardous Waste Handling Facility
- 058 Switchgear Building
- 088 Marketing & Communications
- 089 Behavioral & Social Sciences
- 094 Jensen House
- 096 Shipping & Receiving
- 097 Buck House
- 170 Trinity Annex

036 Mary Warren House

037 Baiocchi House

038 Walter Warren House

039 Toddler Center

040 Natural Resources

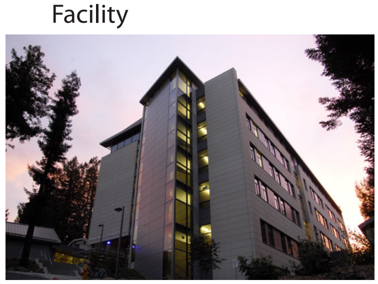
040A Schatz Energy Research Center

046 Facilities Management

048 Hazardous Waste Handling Facility

058 Switchgear Building

088 Marketing & Communications



089 Behavioral & Social Sciences

094 Jensen House

096 Shipping & Receiving

097 Buck House

170 Trinity Annex

4.1.7 SITE TOPOGRAPHY

The topography of the site is a steep grade that rises from the southwest corner of the site to the northeast corner, and which contains a variety of mature tree species, including redwoods. There is a 35 foot differential in grade change from the southwest to the northeast; the site itself is located on a hillside which generally slopes downward from north to south.

https://weatherspark.com/y/310/Average-Weather-in-Arcata-California-United-States-Year-Round#Sections-Topography

Figure 4.1.7.1 - Site Sections

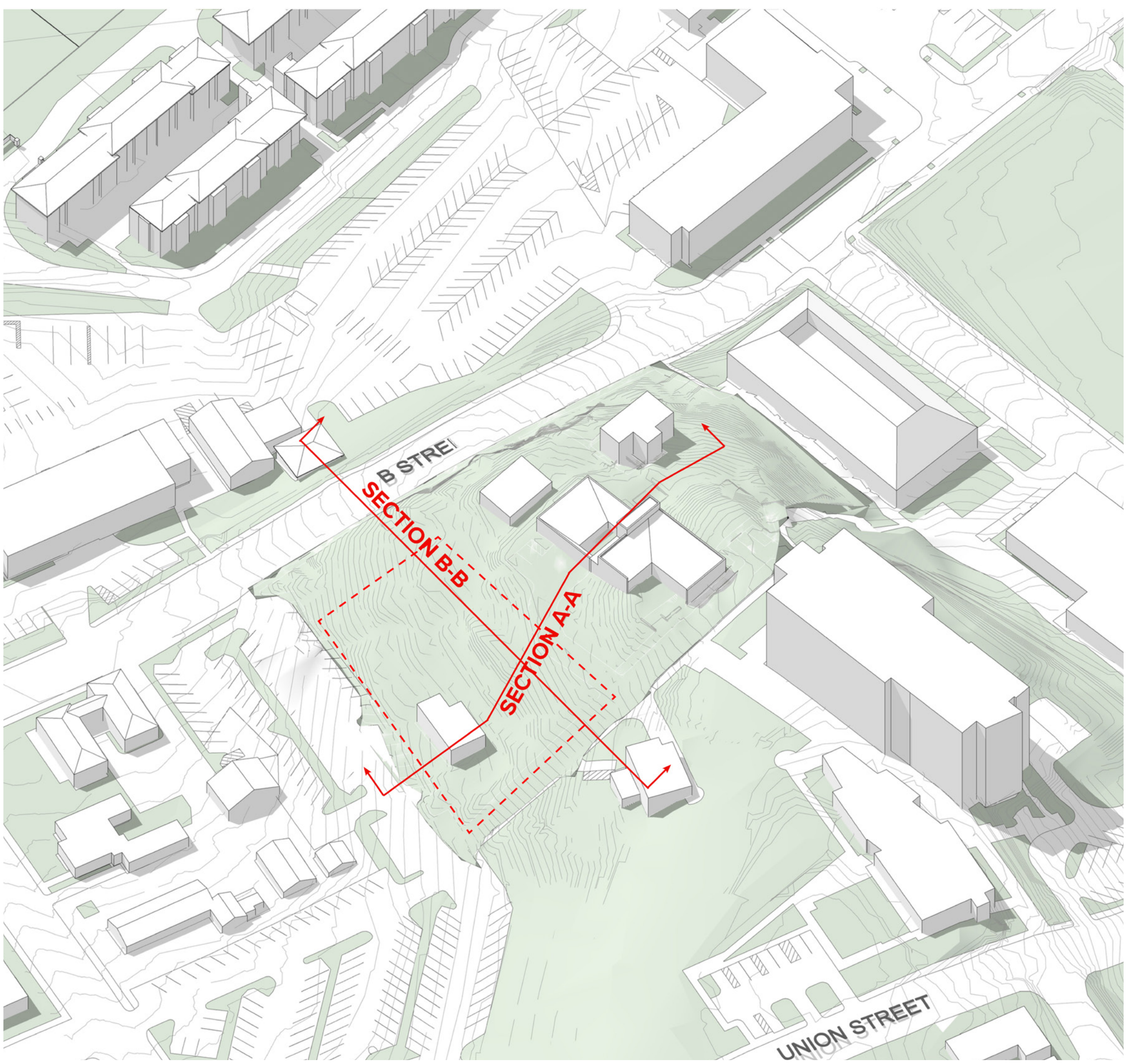


Figure 4.1.7.2 - Site Section A-A

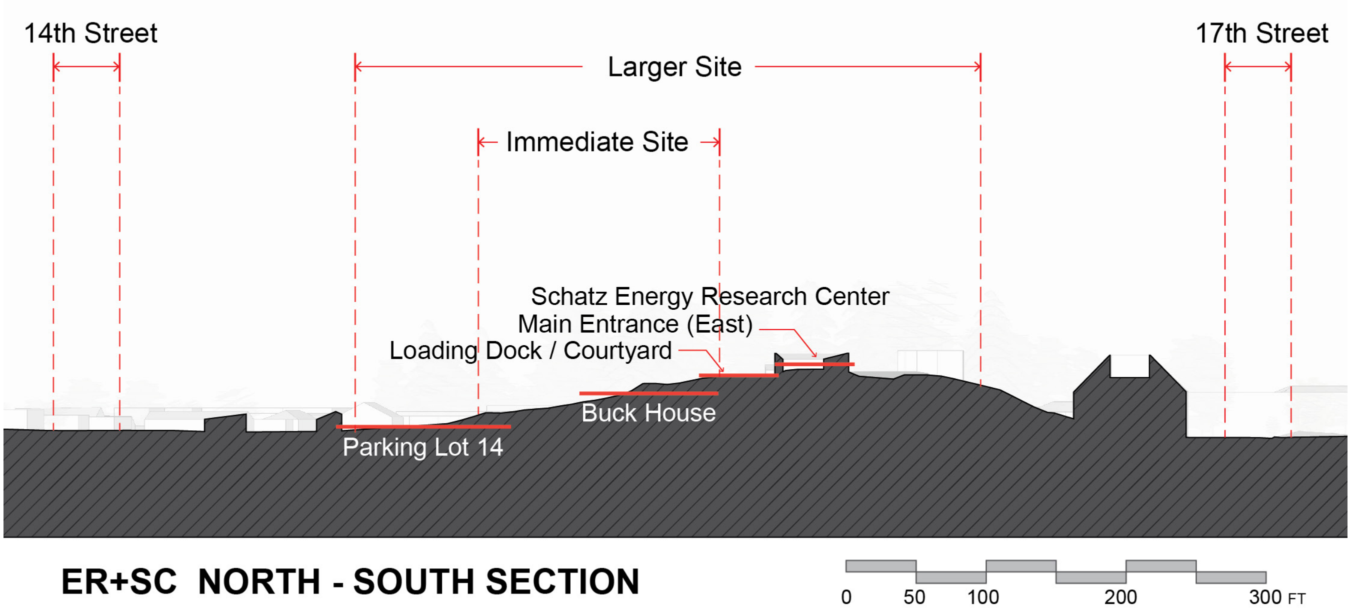
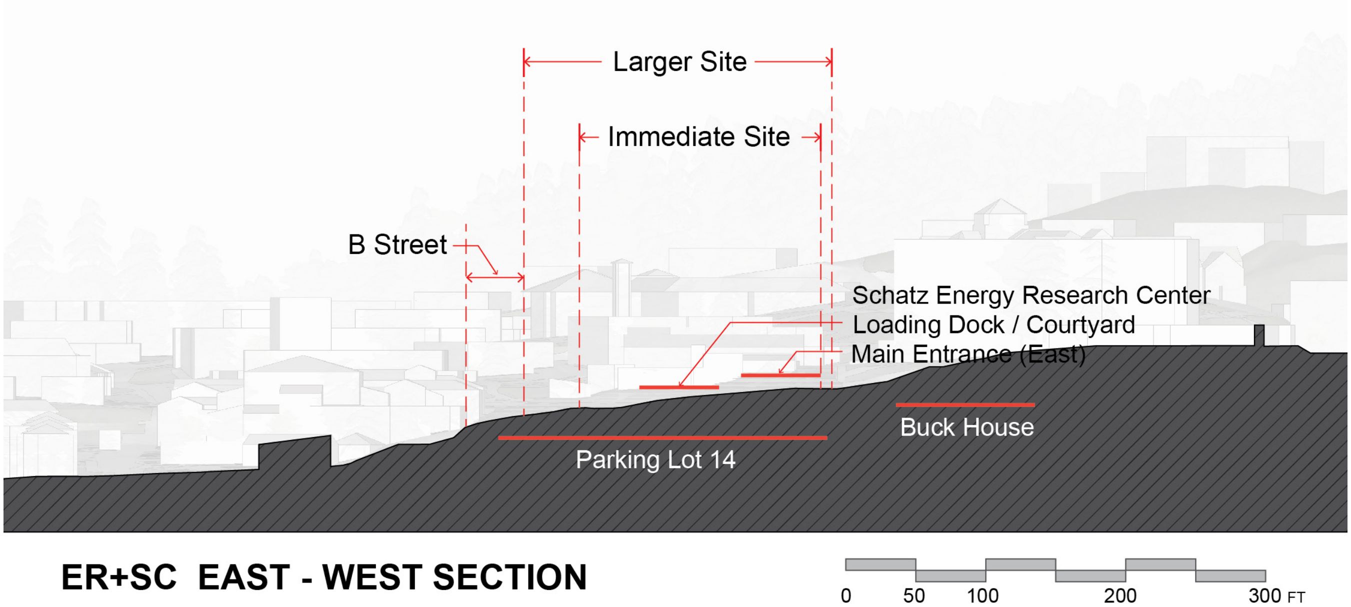


Figure 4.1.7.3 - Site Section B-B



4.1.8 SITE CIRCULATION

With its location at the southern portion of the campus core, north of 14th Street and east of B Street, the project site is well served by a variety of transportation modes. As shown in the Site Circulation Diagram (Figure 4.1.8), major and minor pedestrian pathways surround the site. These pathways connect the southern campus area to the northern campus area and link the ER+SC building site to the Behavioral Sciences and Schatz Energy Research buildings, located at the top of the hill. There is a softscape, meandering pathway that connects from the southwestern corner of the site from B Street to the service street on the eastern edge of the site. Service access to the site is provided from the service drive located to the eastern side of the site. Vehicular parking for the site is provided in an on-grade lot directly south of the site. The site has direct access to bicycle circulation along B Street and serves as a parking location for riders who commute by bike.

Figure 4.1.8 - Site Circulation Diagram

4.1.9 SITE OPEN SPACE

The building is planned to work with sloping site creating terracing opportunities to provide open space on the building itself and reducing affecting the redwood grove to create open spaces.

There is a desire to maintain the informal pathways that currently traverse the site which can also be done across the terrace. The existing informal path running from southwest to northeast has become an open stair along the westside of the building to help connect the buildings in the area while preserving as many redwoods in the grove as possible. It is the intent that the final building should navigate taking the smallest footprint while not dominating the site in shadow.

Figure 4.1.9 - Open Space Connection Diagram

4.1.10 RESILIENCY & SUSTAINABILITY

The project will be designed with the following site sustainability elements:

- LEED Gold
- Retention of redwoods/high value trees as feasible. Trees that must be removed will be considered for reuse within the project or replacement tree will be planted.
- Native/cultural/bee-friendly plant landscape

Additional sustainable goals include a project that is:

- Designed to maximize natural lighting and passive solar heating
- Zero net energy/all-electric
- Rainwater catchment
- Greywater treatment
- Rain gardens to capture run-off
- Living wall
- Solar array on roof

4.1.11 DEMOLITION & SITE PREPARATION

4.1.11.1 SITE IMPROVEMENTS

Preparation of the site for the Energy Research and Sustainability Center building will require the demolition of Jensen House and associated site improvements within the project area. These improvements include new sidewalks to the south and east of the project site, retaining walls, bike parking and the service yard. Sections of the existing drive to the north to be expanded/redesigned to accommodate the loading and service access requirements of the new building. More information on site demolition can be found in Section 5.1.1.1.

4.1.11.2 SITE UTILITIES

The project site contains a number of existing utilities. The normal power to the building will be served from an existing Central Utility Plant with 12.47kV service. See Section 5 additional information on the existing electrical systems and requirements for ensuring capacity for this and future building projects. See the Section 5 Civil narrative for a description of the utility extensions required to provide water supply to the site.

4.1.11.3 SITE PREPARATION

Preparation of the site should follow the requirements outlined in the geotechnical report prepared for the project. Prior to starting demolition and site preparation, the site should be fenced and appropriate pedestrian and traffic controls put in place. More detailed information on site preparation can be found in Section 5.1.

4.1.12 SITE VISITS / OBSERVATION

The following photographs represent some of the most prominent architectural features of the campus context.

Figure 4.1.12.1 - Campus Vocabulary


BEHAVIORAL

4.2 CONCEPT STRATEGIES

4.2.1 MASSING SCENARIOS

For the purposes of the feasibility study, four conceptual test fit options were presented for consideration to address visioning goals and challenges for this program, considering adjacencies, and site related factors. Each option also provided analysis diagrams that supported the evaluation criteria topic areas: Site Context, Function, Staff/Student User Experience, and Community. These diagrams explored mobility/flow, open space, connections between major program areas and indoor/outdoor relationships. The following summary describes each of the concepts and defining features explored.

Figure 4.2.1.1 - Existing Site and Generic Massing

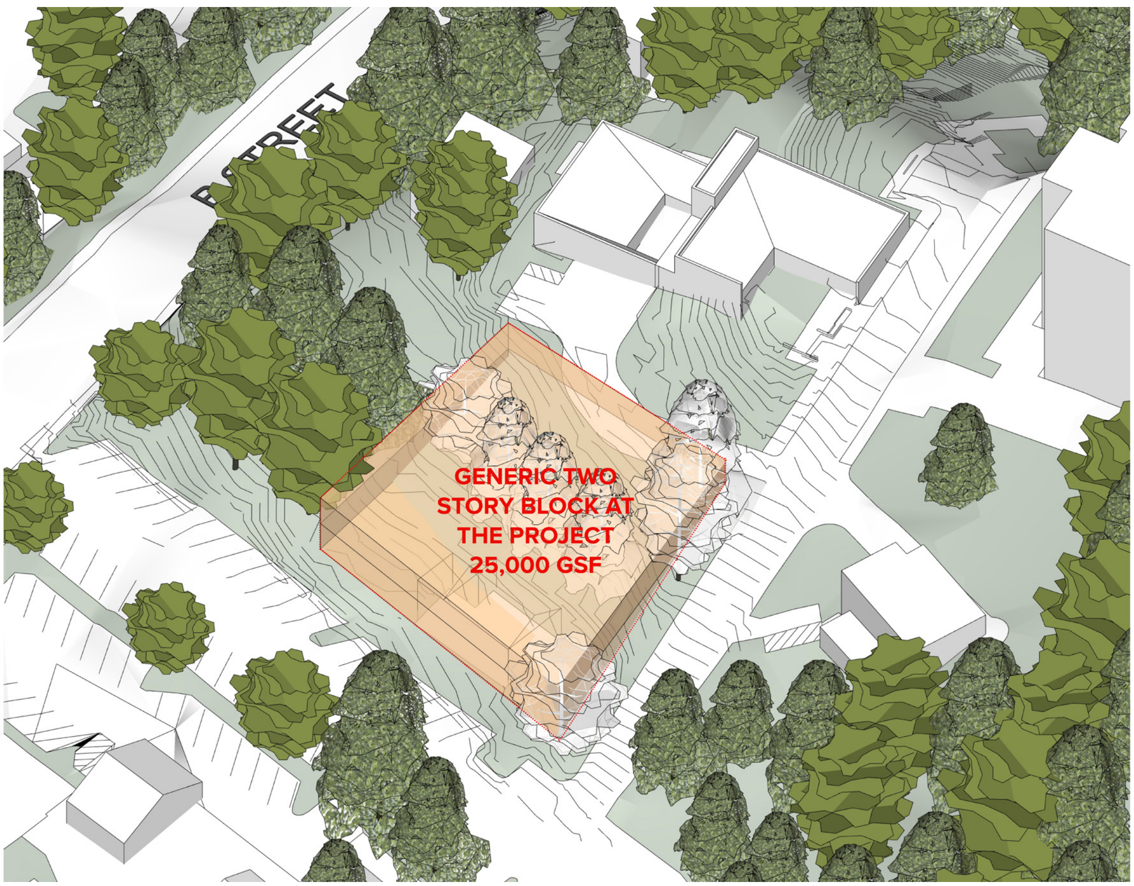
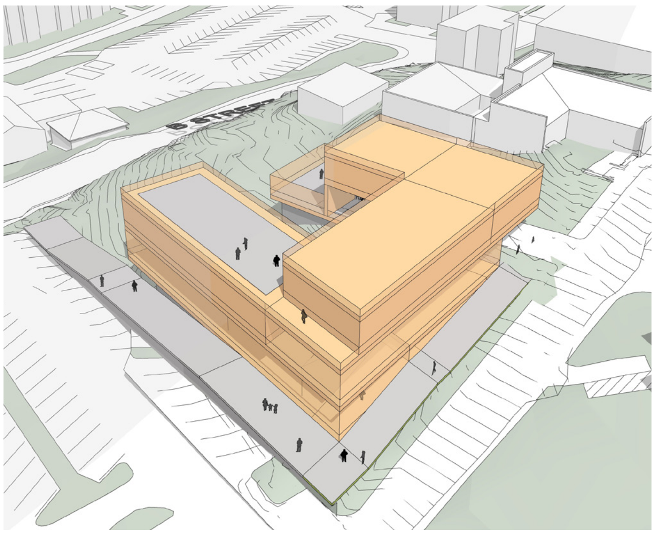
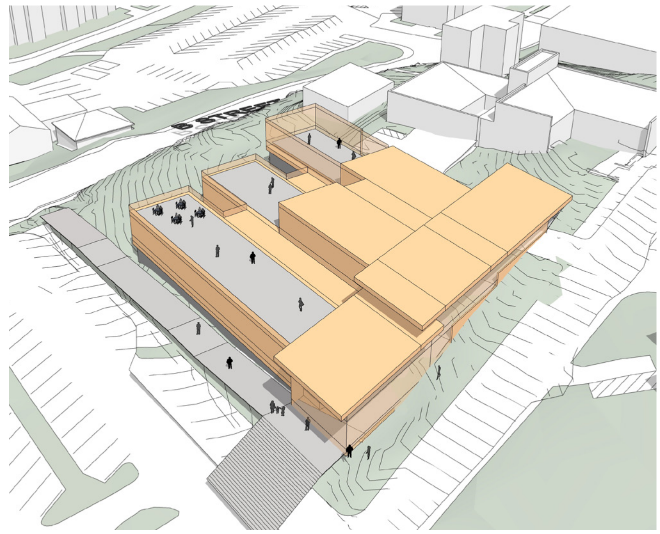


Figure 4.2.1.2 - Massing Scenarios

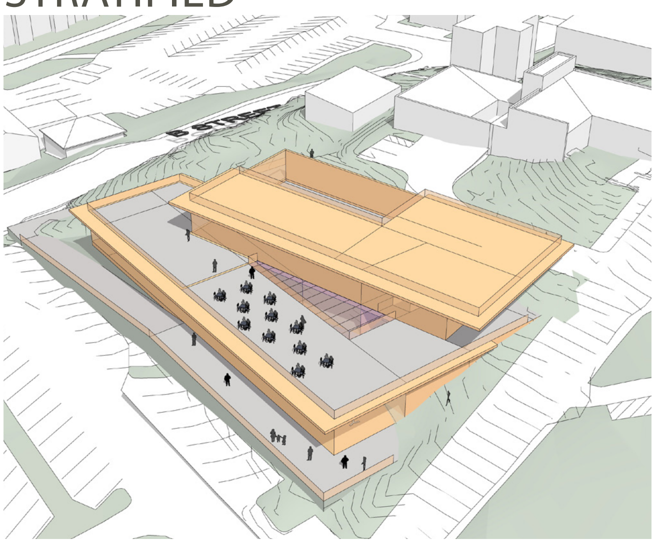
SPIRAL



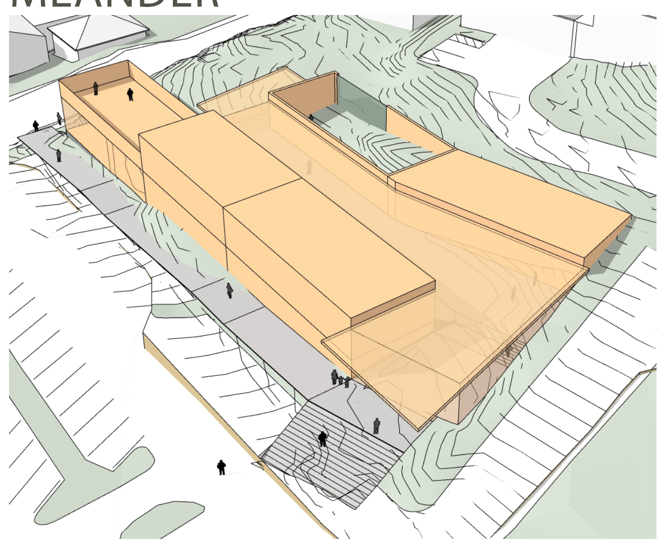
FINGERS



STRATIFIED



MEANDER

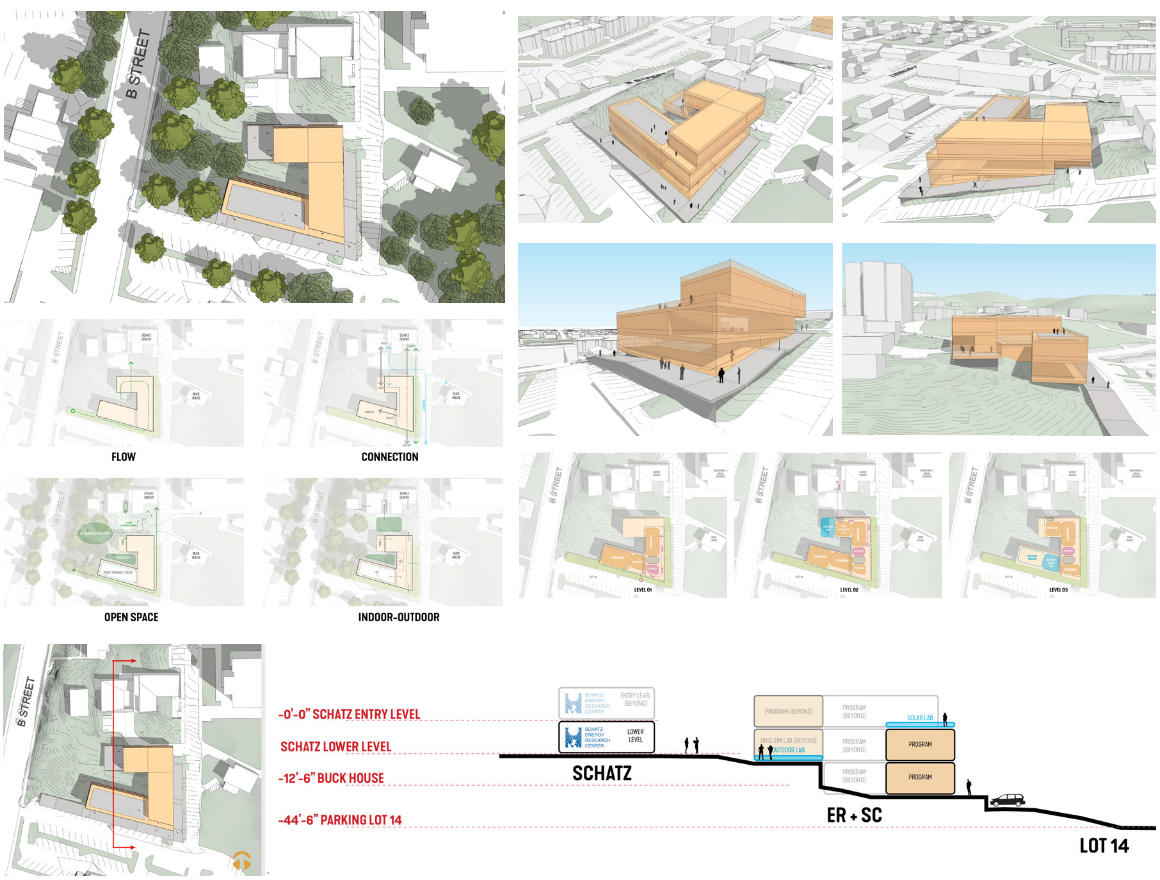


4.2.2 SPIRAL

Concept: Spiral intertwines with the natural landscape. A compact 'horseshoe' footprint preserves the redwood grove to the west and allows the terrain to slide between the arms of the building. In doing so, nuanced daylight and viewing experiences are captured from the interior, ranging from sun-filled spaces with a southern view to quiet nestled areas towards the center of the site.

1. The outdoor terrace sits on the lowest arm of the architecture, unhindered in view and access to daylight, optimized for solar infrastructures and viewing leisure.
2. The outdoor lab is located at grade with the northward Schatz Center, providing greater opportunity for cross-pollination and ease of flow.
3. Other defining features for comparison:
    - Three level solution
    - Compact footprint
    - Comparatively larger quantity of trees retained
    - Encroaches into existing service drive.
    - Upper level solar lab

Figure 4.2.2 - Massing Scenario : Spiral

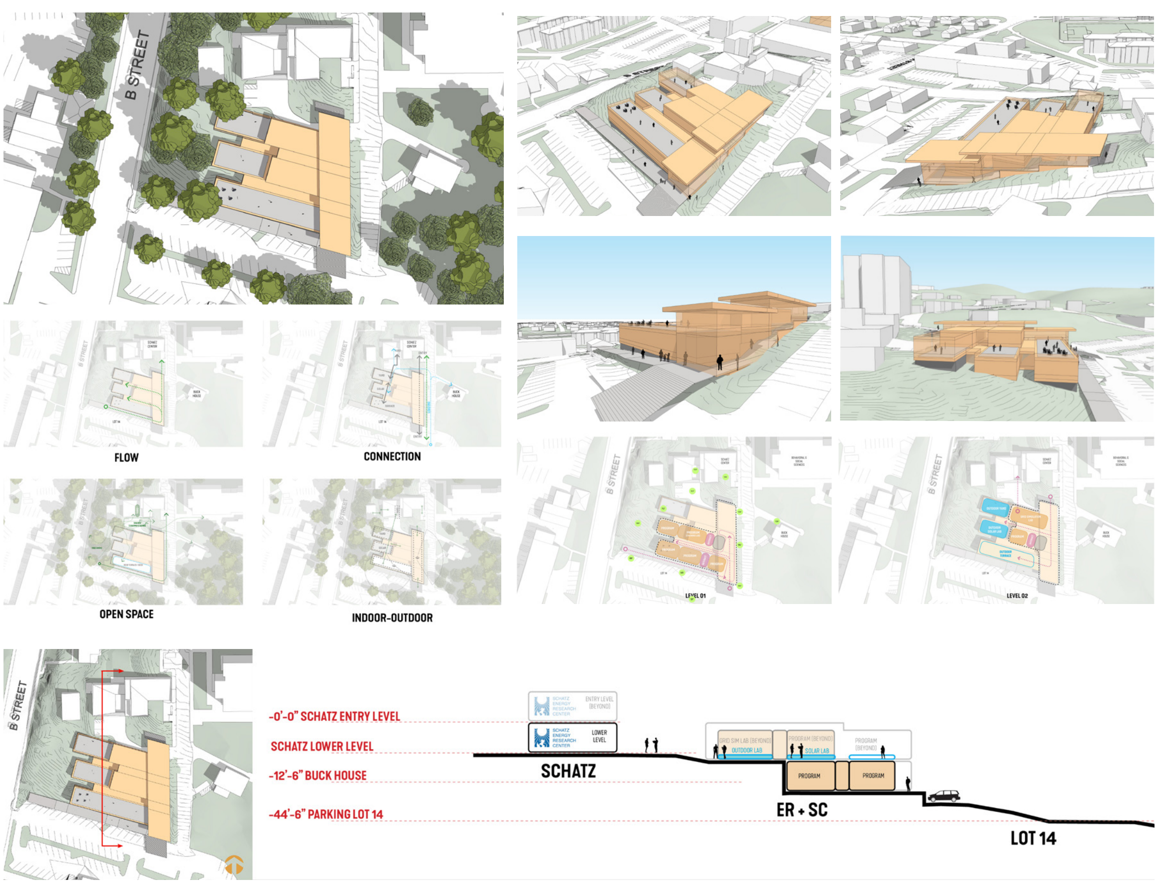


4.2.3 FINGERS

Concept: Fingers features a double-height interior arcade that tethers each program-filled wing as they extend towards the westward redwood grove. Given the dramatic grade change on site, each wing cascades down the hill, reducing the architecture's perceived height and allowing light to reach each building's face.

1. The roofscape of each program wing is capped by exterior terrace space, a mix of learning labs, solar testing, and a social break-out space with a view.
2. An elevated walkway leads pedestrians up the hill from B Street to the building arcade's south entry.
3. Other defining features for comparison:
   - Two level solution
   - Larger footprint
   - Comparatively larger quantity of trees impacted
   - Encroaches into existing service drive
   - Outdoor yard has direct access to the Solar Lab

Figure 4.2.3 - Massing Scenario : Fingers

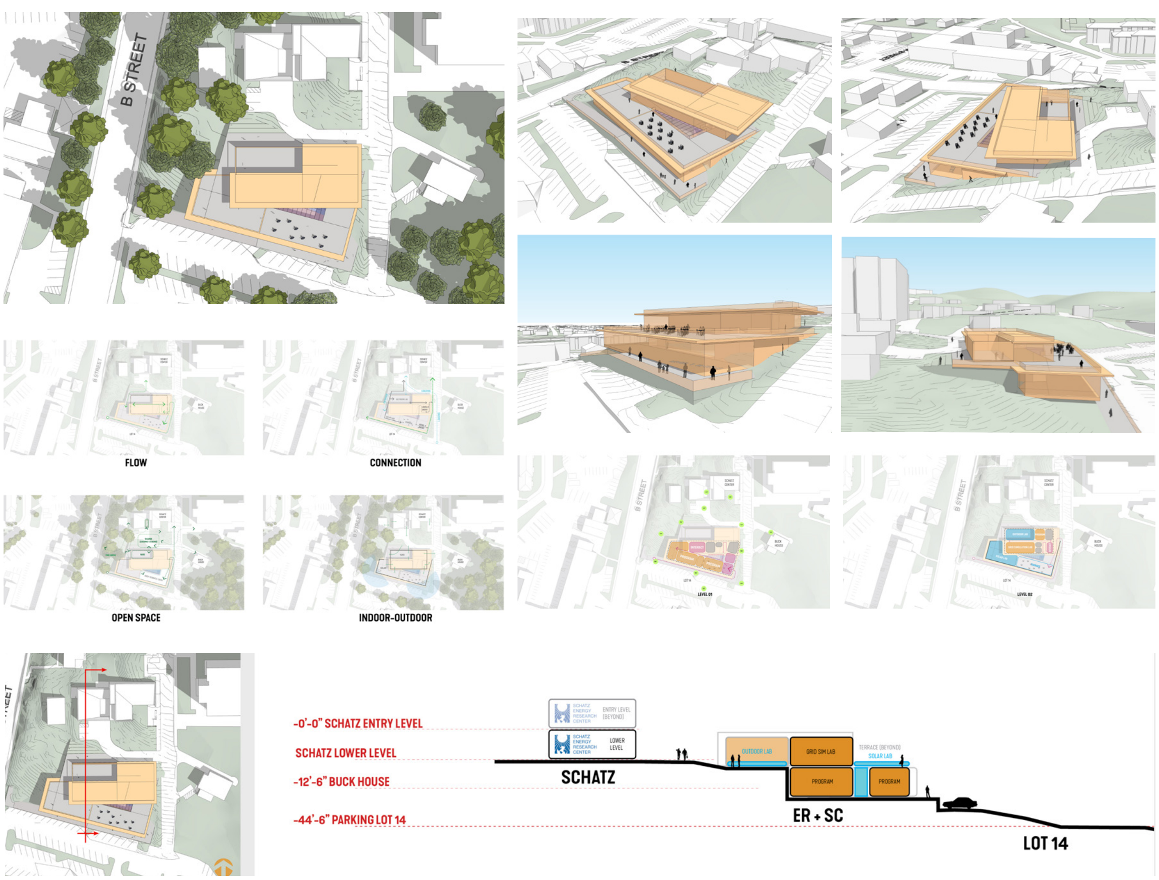


4.2.4 STRATIFIED

Concept: Stratified celebrates the natural dynamic topography by terracing towards the south, in doing so, providing multiple access points along the site periphery, elevating exterior work and gathering space, and creating opportunities to bring daylight deeper within the building footprint.

1. The south-facing wrap-around terrace is unhindered, serving as the optimal test site and display of solar infrastructures. The terrace is at grade with the northward Schatz Center, providing greater opportunity for cross-pollination and ease of flow.
2. While the upper-level clusters the Microgrid research and instructional spaces, the lower level serves as the front door to campus, featuring a mix of resource spaces, offices, and student workspaces that look out onto the redwood grove.
3. Other defining features for comparison
   - Two level solution
   - Larger footprint
   - Comparatively larger quantity of trees impacted
   - Existing service drive unaffected
   - Outdoor yard has direct access to the Solar Lab

Figure 4.2.4 - Massing Scenario : Stratified

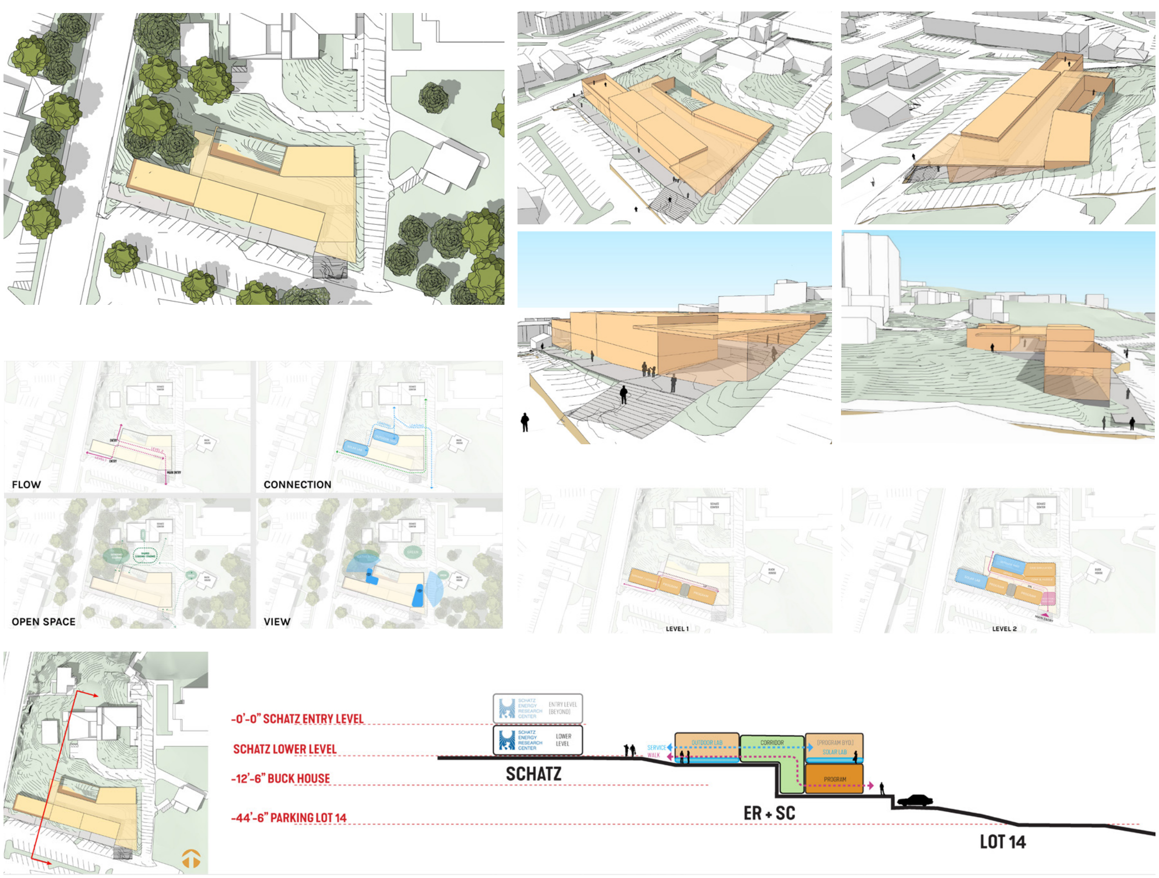


4.2.5 MEANDER

Concept: Massing option Meander is a two-level building that celebrates the direct entry at B street. Its east-west oriented central corridor is also inspired by the existing path meandering through the forest. The building footprint's compressed depth preserves the existing service drive and provides direct access to outdoor yard and solar lab.

1. The concept also provides a new exterior pedestrian site path that promotes flow from central campus to the project site from both the B-Street side, the Schatz Center and neighboring buildings.
2. Other defining features for comparison
    - Two level solution
    - Closest to B-Street, Connection between East-West
    - Low Building Height
    - Existing service drive unaffected
    - Outdoor yard has direct access to the Solar Lab

Figure 4.2.5 - Massing Scenario : Meander



4.3 CONCEPT EVALUATION CRITERIA / FEEDBACK

4.3.1 CONCEPT OPTION EVALUATION

The 4 Massing Scenarios were evaluated using criteria in four areas: Site Context, Function, Student/ Staff UX and Community with the specific priorities identified below. Then, through a process of voting on the options based on the criteria topic and providing detailed notes that influenced their decisions – the data results and comments were revealed to the group for further discussion and consideration.

1. Creates a Strong presence on cluster court and B-Street while having appropriate scale for the site context. (Site)
2. Strong Relationship to Schatz Center and CCAT that doesn't impact access to neighboring sites and height of building works with hillside and neighbors.) (Site)
3. Respectful of campus context (existing trees and impact on existing site) and user accessibility.Ease of Mobility and Circulation (Site)
4. Microgrid program adjacencies streamlined support world class research facility. (optimize functions) (Function)
5. In-Practice Sustainability integrated in all aspects of the building function and experience, Optimize solar orientation, etc (Function)
6. Fosters high collaboration between ER + SC users with highly functional and flexible relationships between areas (Function)
7. Research on Display - supports student belonging, curiosity and engagement in energy research and sustainability. (Staff/Student UX)
8. Organization supports informal learning with spaces that offer multiple uses and flexibility. (Staff/ Student UX)
9. Spaces promote holistic wellness - natural light, views, indoor/outdoor connections. (Staff/Student UX)
10. Welcoming Hub with clear wayfinding and ease of navigation for students and community (Community)
11. Viewed as community resource with areas for public gathering and support (Community)
12. Accessible to All - universal access to site resources including, provisions to support exchange with larger community. (Community)

Figure 4.3.0 - Concept Option Evaluation

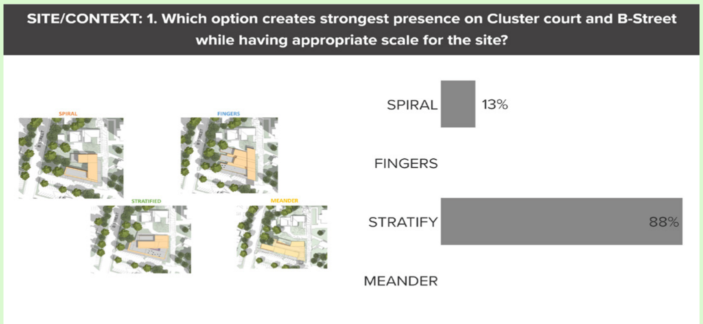
SITE CONTEXT	1.Creates a Strong presence on cluster court and B-Street while having appropriate scale for the site context 2. Strong Relationship to SERC and CCAT that doesn't impact access to neighboring sites and height of building works with hillside and neighbors.) 3. Respectful of campus context (existing trees and impact on existing site) and user accessibility. Ease of mobility and circulation
FUNCTION	4. Microgrid program adjacencies streamlined support world class research facility. (optimize functions) 5. In-Practice Sustainability integrated in all aspects of the building function and experience, Optimize solar orientation, etc 6. Fosters high collaboration between ER + SC users with highly functional and flexible relationships between areas
STUDENT / UX	7. Research on Display - supports student belonging, curiosity and engagement in energy research and sustainability. 8. Organization supports informal learning with spaces that offer multiple uses and flexibility 9.Spaces promote holistic wellness - natural light, views, indoor/outdoor connections
COMMUNITY	10. Welcoming Hub with clear wayfinding and ease of navigation for students and community 11. Viewed as community resource with areas for public gathering and support 12. Accessible to All - universal access to site resources including, provisions to support exchange with larger community

4.3.1 CONCEPT OPTION EVALUATION, CONTINUED

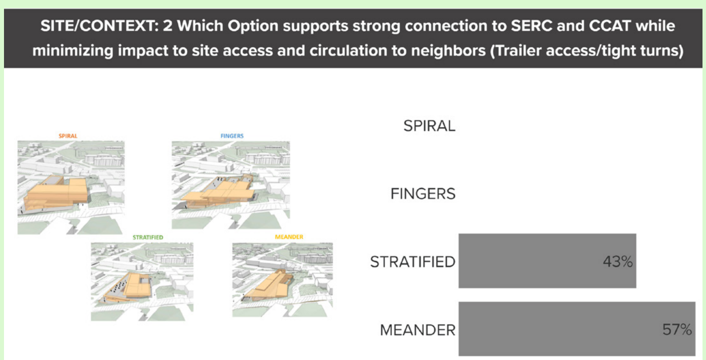
The following 8 pages show the results of the evaluation for the 4 concept strtategies presented based on the criteria defined above. From the voting outcomes it is important to note that the prevailing option that was selected for each criteria prompt was only half of the answer. The detailed reasons for these preferences were very effective in communicating nuanced attitudes and concerns about each proposed option that prompted productive discussion with the stakeholders.

4.3.1.1 SITE CONTEXT

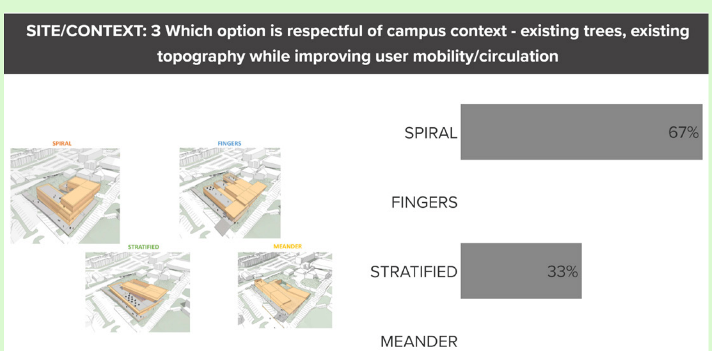
1. Which option creates strongest presence on Cluster court and B-Street while having appropriate scale for the site?



2. Which Option supports strong connection to Schatz Center and CCAT while minimizing impact to site access and circulation to neighbors (Trailer access/ tight turns)



3. Which Option is respectful of campus context- existing trees, existing topography while improving user mobility/ circulation?



SITE/CONTEXT: 1. What aspects/features motivated your decision?

- 0 | Building has a long south-facing side that will be visible from B St while (potentially) allowing some of the larger redwood trees on the western side of the l...
- 0 | The large outdoor area that has the potential to draw people into the space
- 0 | The stratified concept offers natural light, and access to outdoor space, and less impact on trees, driveways and existing structures
- 0 | The wrap-around terrace so that there are views from the terrace to the streets and vice versa. The extension of the building to the west to get closer to B st...
- 0 | large open deck on the south side, lower profile than spiral. I dislike its impacts on the redwood grove but the least impactful design (spiral) creates its o...
- 0 | Lower profile in comparison to spiral
- 0 | Stratify makes the best use of solar exposure for the outdoor spaces. The outdoor terrace on the south east corner provides a great presence on Cluster Court. ...
- 0 | responsive to the hillside, creates a working plane with access to South side from Schatz loading level . it just looks good

|0| Building has a long south-facing side that will be visible from B St while (potentially) allowing some of the larger redwood trees on the western side of the lot to remain. Cluster court presence is good, and building does not require significant changes to the Schatz Center driveway.

|0| large open deck on the south side, lower profile than spiral. I dislike its impacts on the redwood grove but the least impactful design (spiral) creates its own set of issues

|0| The wrap-around terrace so that there are views from the terrace to the streets and vice versa. The extension of the building to the west to get closer to B street.

|0| Stratify makes the best use of solar exposure for the outdoor spaces. The outdoor terrace on the south east corner provides a great presence on Cluster Court. The west side will provide an inviting angle enouraging people to approach from B street, especially if there is an entrance stair on the SW.

SITE/CONTEXT: 2. What aspects/features motivated your decision?

- | 0 | Pathways from Schatz Center and CCAT are both good. The outdoor lab and and solar lab are both easily accessed from the Schatz Center without entering the buil...
- | 0 | The driveway seems to have the least impact with this concept
- | 0 | Set farther back from driveway. All of the buildings have good SERC connectivity. The third story on Sprial is too high and would be disruptive on the site, im...
- | 0 | I expect that low profile of stratified won't shade out SERC or CCAT. Maintaining as many trees as possible will help
- | 0 | The fact that there is such a large outdoor terrace that is roughly at the same elevation as the lower level of SERC and CCAT. It really connects these two lon...
- | 0 | narrowed the site to run along Southern edge creating more free space between buildings/ driveways

|0| Pathways from Schatz Center and CCAT are both good. The outdoor lab and and solar lab are both easily accessed from the Schatz Center without entering the building. The building does not appear to interfere with the Schatz Center driveway.

Set farther back from driveway. All of the buildings have good SERC connectivity. The third story on Sprial is too high and would be disruptive on the site, impeding sight lines from uphill buildings.

|0| The fact that there is such a large outdoor terrace that is roughly at the same elevation as the lower level of SERC and CCAT. It really connects these two long standing campus institutions, which is perfect given the purpose of this building. Also Stratify has the best solar access/orientation.

SITE/CONTEXT: 3. What aspects/features motivated your decision?

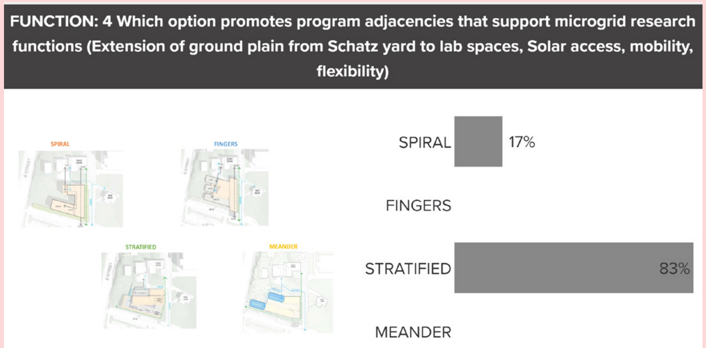
- | 0 | The exterior walking pathway from B St to the Behavioral and Social Sciences Building is best in the Spiral design. This building appears to minimize tree remo...
- | 0 | The building is closer to the east side of the site than the west side where the trees are
- | 0 | Spiral preserves the most trees. Stratified honors the topography best. It is hard to pick between them.
- | 0 | While Spiral appears to have the lowest impact on the land, Stratifyhas the most potential to improve mobility and circulation in this part of campus and it co...
- | 0 | while it does not protect existing trees, it does play seamlessly with the hill side and give maximum ped access

|0| While Spiral appears to have the lowest impact on the land, Stratifyhas the most potential to improve mobility and circulation in this part of campus and it connects the Schatz Center and CCAT. It looks like Stratify would result in one more tree being removed compared to Spiral, so not a huge diff.

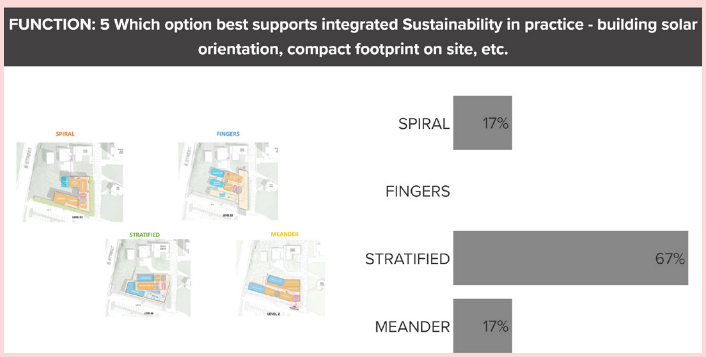
|0| The exterior walking pathway from B St to the Behavioral and Social Sciences Building is best in the Spiral design. This building appears to minimize tree removal and also includes a very nice gathering / clearing space.

4.3.1.2 FUNCTION

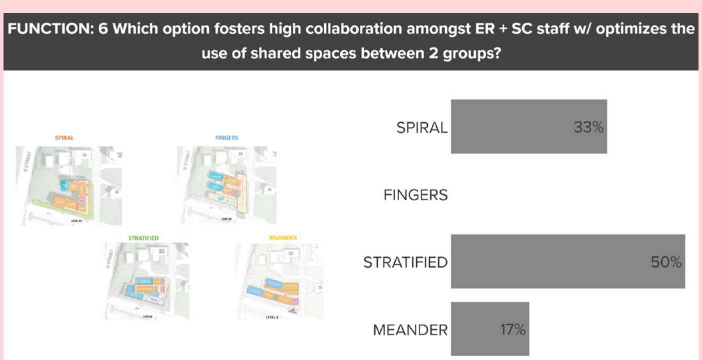
1. Which option promotes program adjacencies that support microgrid research functions (Extension of ground plain from Schatz yard to lab spaces, Solar access, mobility, flexibility)



2. Which option best supports integrated Sustainability in practice- building solar orientation, compact footprint on site, etc.



3. Which option fosters high collaboration amongst ER+SC staff w/ optimizes the use of shared spaces between 2 groups?



FUNCTION: 4 What aspects/features motivated your decision?

| o | This design provides easy pathways from the Schatz Center to both the outdoor lab (and grid simulation lab) and the outdoor solar lab. It appears to be possibl...

| o | It just seems to flow better

| o | The adjacencies of the outdoor test yard, the grid simulation lab, and the solar lab are excellent. If the energy research teaching/training lab is located in ...

| o | working plane at Schatz loading level, maximized south facing edge for working deck

|o| This design provides easy pathways from the Schatz Center to both the outdoor lab (and grid simulation lab) and the outdoor solar lab. It appears to be possible to access the outdoor solar lab from the Schatz Center without entering the building, which is ideal.

|o| The adjacencies of the outdoor test yard, the grid simulation lab, and the solar lab are excellent. If the energy research teaching/training lab is located in the program area to the east of the outdoor yard, and ER offices on second level, then the adjacency would be excellent all ER facilities.

FUNCTION: 5 What aspects/features motivated your decision?

| o | The stratified design has the best balance between south facing roof and wall space space (for solar rooftop installation and also passive solar design) while ...

| o | compact footprint, skylight for natural light, appears the second floor could feel like you are in the canopy

| o | Access of all spaces to sunlight. The central skylight bringing daylight into the core of the first story is nice, as there will otherwise be some spaces on th...

| o | Stratify has the best solar access design, which is at the heart of sustainability. It also connects and integrates SERC and CCAT by virtue of the large terrac...

| o | most solar exposure

|o| The stratified design has the best balance between south facing roof and wall space space (for solar rooftop installation and also passive solar design) while also extending less to the west (thereby preserving more of the larger redwood trees).

|o| Access of all spaces to sunlight. The central skylight bringing daylight into the core of the first story is nice, as there will otherwise be some spaces on the first story without good light. This addresses that "dark corners" issue best. Spiral might be the lowest energy use, though?

|o| Stratify has the best solar access design, which is at the heart of sustainability. It also connects and integrates SERC and CCAT by virtue of the large terrace that is roughly at the same elevation of the lower level of the Schatz Center and CCAT. Creates an integrated hub for sustainability.

FUNCTION: 6 What aspects/features motivated your decision?

| o | The stratified design has lots of interactive spaces on Level 1. It isn't clear where the office spaces are in any of the designs, making this criterion somewh...

| o | Each level of the building could support a particular group

| o | The corridor / flow through the core of the building.

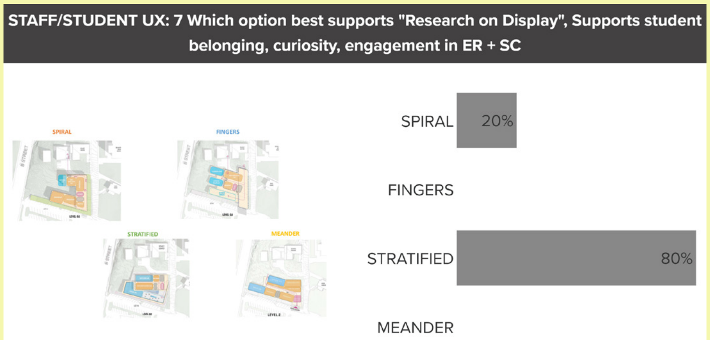
| o | a center unifying skylight/ open court brings connection between floors. the building plans supports existing pedestrian paths which will bring people across t...

|o| The stratified design has lots of interactive spaces on Level 1. It isn't clear where the office spaces are in any of the designs, making this criterion somewhat harder to access.

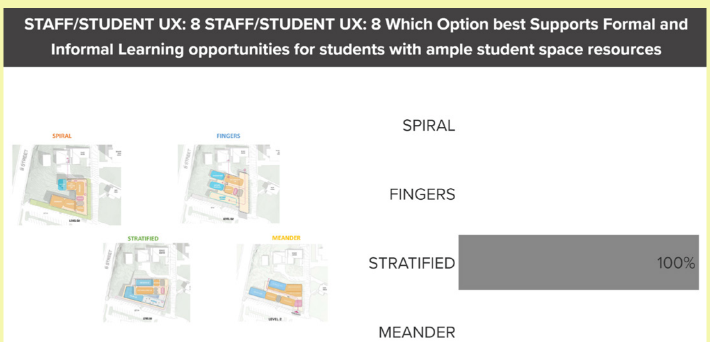
|o| a center unifying skylight/ open court brings connection between floors. the building plans supports existing pedestrian paths which will bring people across the building and cause interaction between building visitors

4.3.1.3 STUDENT / STAFF UX

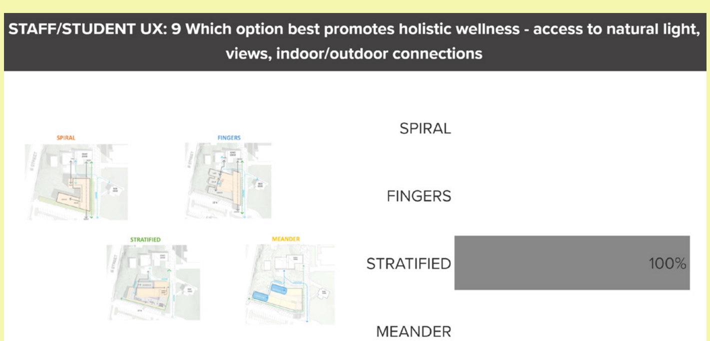
1. Which option best supports "Research on Display", Supports student belonging, curiosity, engagement in ER+ SC?



2. Which Option best Supports Formal and Informal Learning opportunities for students with ample student space resources?



3. Which Option best promotes holistic wellness- access to natural light, views, indoor/outdoor connections?



STAFF/STUDENT UX: 7 What aspects/features motivated your decision?

- The combination of interactive spaces and the comfortable adjacency between the outdoor terrace and the solar roof lab make the stratified design strong in rel...
- This was hard to decide between strafied and spiral. I really like the large terrace of stratified but the indoor reception space in the spiral concept is why ...
- Space for public access to the terrace will draw people to the building. The linear Guggenheim also.
- The solar lab, grid sim lab, and outdoor lab are on the same level as the big terrace that integrates the Schatz Center and CCAT. I think that the large terrac...
- see answer to question 12

The combination of interactive spaces and the comfortable adjacency between the outdoor terrace and the solar roof lab make the stratified design strong in relation to this metric.

This was hard to decide between strafied and spiral. I really like the large terrace of stratified but the indoor reception space in the spiral concept is why I selected it.

The solar lab, grid sim lab, and outdoor lab are on the same level as the big terrace that integrates the Schatz Center and CCAT. I think that the large terrace will be a popular place on campus and that we will be able to engage the campus community as they interact with the building on the terrace

STAFF/STUDENT UX: 8 What aspects/features motivated your decision?

- The easily accessible outdoor terrace space helps make the stratified design welcoming for students.
- This was a bit hard to assess, as it isn't clear what all of the spaces are in the respective designs. Having multiple interactive spaces is positive. Having t...
- I will not be teaching in this building so I really don't know
- Stratify layout supports good engagement with people entering from the southeast corner: large interaction space, natural light, etc. Entering from the south w...
- indoor + outdoor space is critical to invite informal collaboration.
- see answer to question 12, also the building will draw people in while preserve connection to the outdoors

This was a bit hard to assess, as it isn't clear what all of the spaces are in the respective designs. Having multiple interactive spaces is positive. Having the teaching lab close to the grid simulation lab and/or the outdoor solar lab also enhances learning.

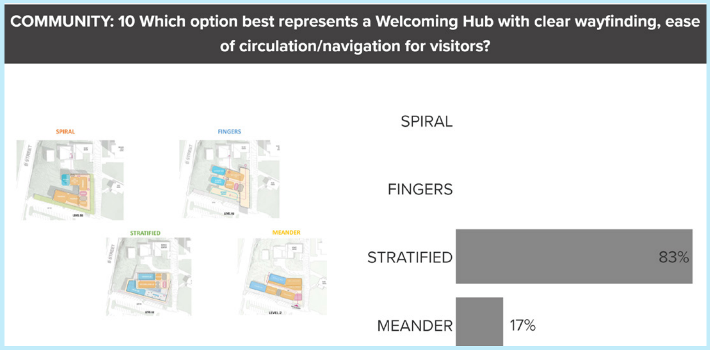
Stratify layout supports good engagement with people entering from the southeast corner: large interaction space, natural light, etc. Entering from the south west onto the terrace would be beautifully engaging in a different way. Placement of solar lab on exterior terrace seems challenging.

STAFF/STUDENT UX: 9 What aspects/features motivated your decision?

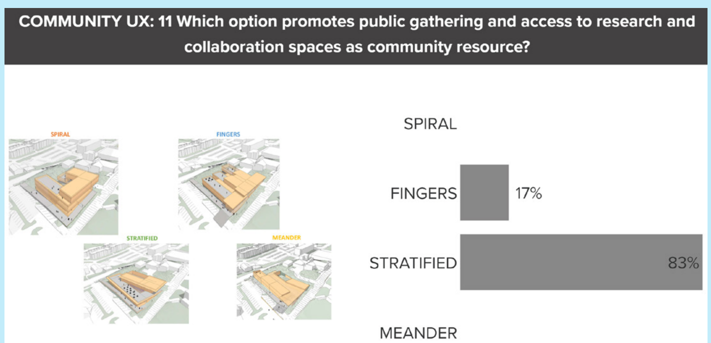
- skylight and easy access to outdoor terrace
- The terrace
- tiered use of the site, gives opportunityfor solar gain and viewing in various parts of the building

4.3.1.4 COMMUNITY

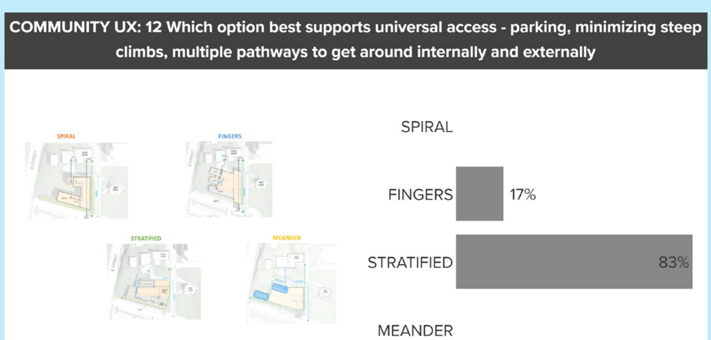
1. Which option best represents a Welcoming Hub with clear wayfinding, ease of circulation/ navigation for visitors?



2. Which option promotes public gathering and access to research and collaboration spaces as community resource?



3. Which option best supports universal access- parking, minimizing steep climbs, multiple pathways to get around internally and externally?



COMMUNITY UX 10: What aspects/features motivated your decision?

0	The stratified design seems simple and easy to navigate.
0	From B street this concept is attractive
0	Stratify has a large interact space at the entrance in the south east corner and also has the best potential for good circulation patterns in this part of campus.
0	central corridor / pathway through the core facilities provides more access.
0	see answer to question 12

COMMUNITY UX 11: What aspects/features motivated your decision?

0	The roof terrace and its adjacency to the outdoor solar lab is an asset in relation to this metric. It isn't clear which room is the event space, but one possi...
0	The terrace attracts people and then they come inside the building to learn more
0	I think the lower level of stratified has the most potential to be inviting and interactive.
0	Hard to say. I feel it is a tie between Fingers, Stratified, and Meander. All do different things well. Large public terraces (F,S), and a central corridor pat...
0	it's about the connection to outdoors and natural pathways activations the hillside. p

0	The roof terrace and its adjacency to the outdoor solar lab is an asset in relation to this metric. It isn't clear which room is the event space, but one possibility is the westernmost room on Level 1. If so, this could be designed with very attractive views of the the redwood grove to the west.

0	Hard to say. I feel it is a tie between Fingers, Stratified, and Meander. All do different things well. Large public terraces (F,S), and a central corridor pathway (M).

COMMUNITY UX 12: What aspects/features motivated your decision?

0	The simplicity of the stratified design is helpful. Several designs have only 2 levels, which is also helpful in this regard.
0	through lines from the parking lot to up the hill or from the top of hill down to the parking lot. Clear east-west flow within the fingers
0	Stratified provides great circulation potential externally and good circulation internally. The large terrace supports mobility accross the site and eases acce...
0	Connection to B street and the foot of cluster court, then up to the level of the Schatz Driveway.
0	see answer to question 12

0	Stratified provides great circulation potential externally and good circulation internally. The large terrace supports mobility accross the site and eases access to the Schatz Center and CCAT. If one can enter at the SE corner and take an elevator up the the terrace level that would be great.

4.4 PRIME CONCEPT STRATEGY SELECTED

Based on the data from the evaluation criteria polling and discussions of detailed drivers behind the selections, the massing option labeled "Stratified" was selected for the most successful delivery of desired criteria goals including the following:

- The 2-level massing strategy is most respectful of the site and existing topography, while leveraging the elevation transitions to provide accessibility to the roof level solar lab from the north and vehicular adjacency to the Schatz Energy Center court without modifying current roadway.
- Southern orientation of solar lab and terraces above the level 1 program allows for visibility of the research while also providing welcoming outdoor space for collaboration.
- Level 2 laboratory research and support spaces have a closer adjacency to Schatz Center while also affording controlled access and secondary entry for safety concerns related to research technology.
- Strong indoor/outdoor relationships into the adjacent landscape, while also strengthening the presence of the new building along B-Street (higher visibility) while also incorporating aspects of Meander option that had intentional outdoor pathways to augment indoor circulation options around the site.

Figure 4.4.1 - STRATIFIED Massing Scenario

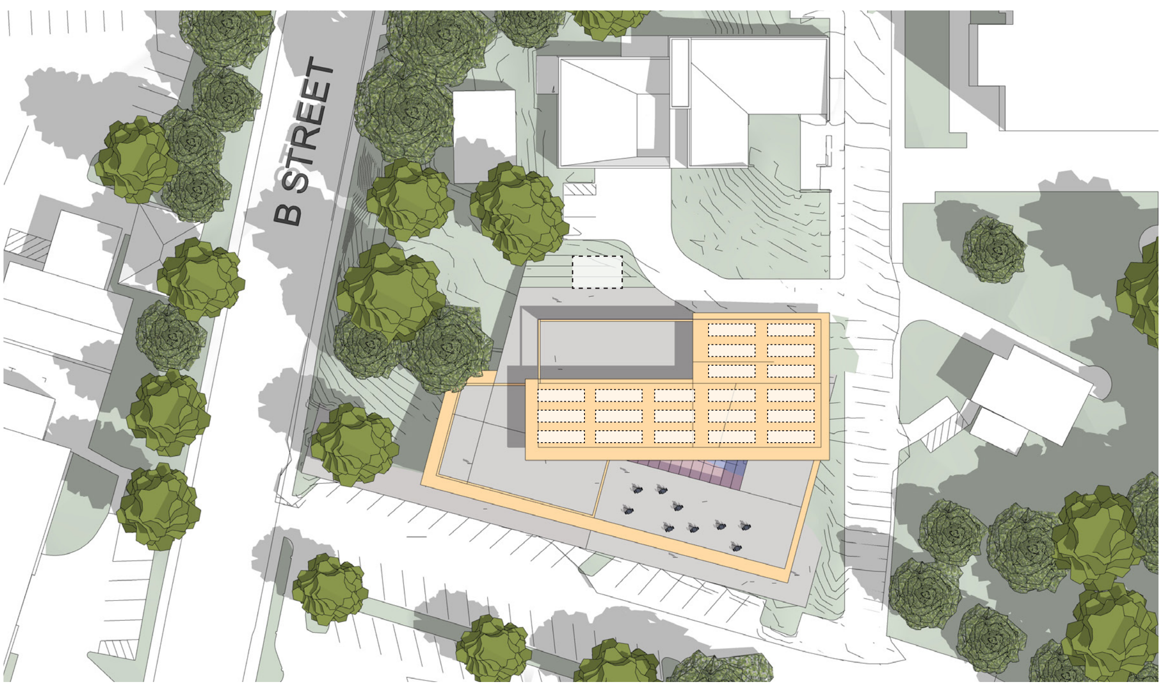
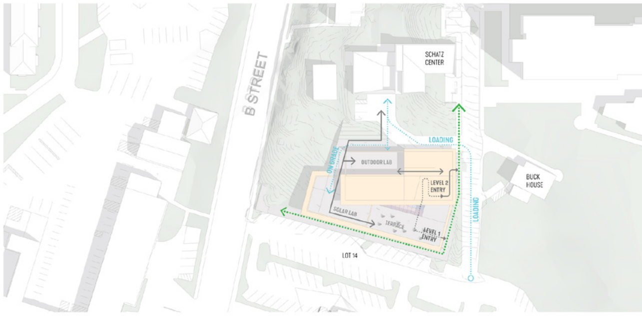
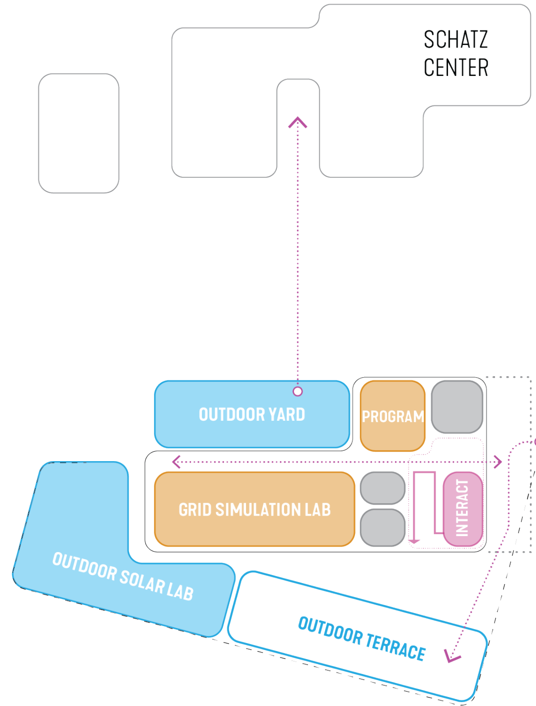


Figure 4.4.2 - STRATIFIED Massing Scenario - Selected Option



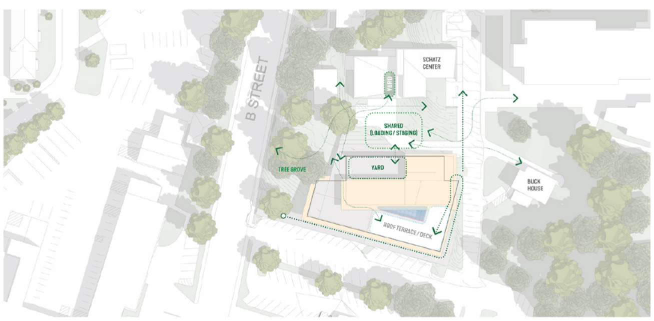
CONNECTION



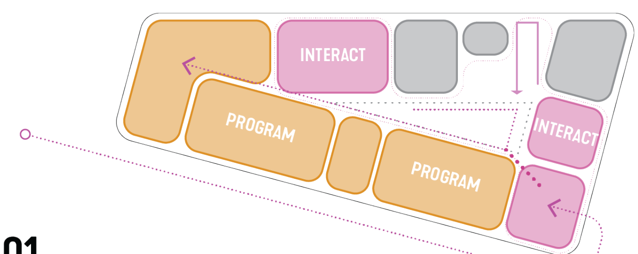
LEVEL 02

INDOOR-OUTDOOR

02

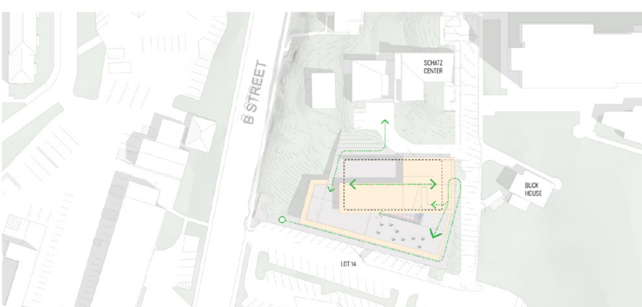


OPEN SPACE

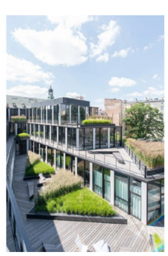


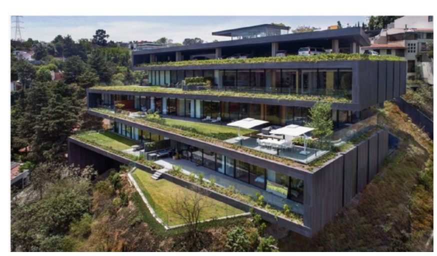
01

LEVEL 01



FLOW

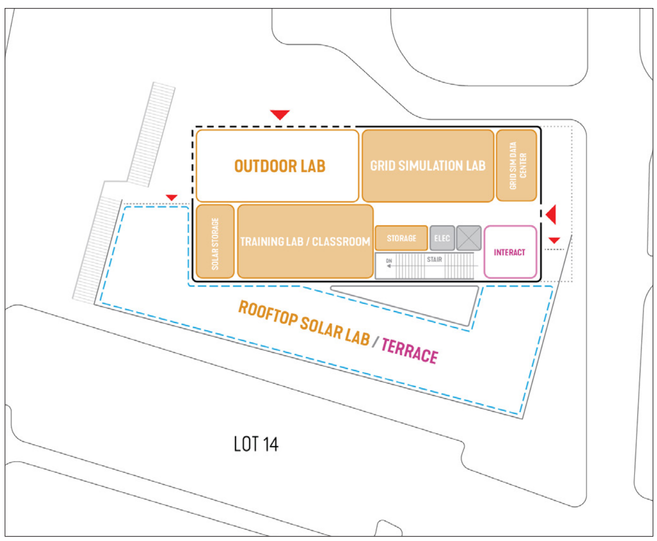


4.5 PLANNING TEST-FIT

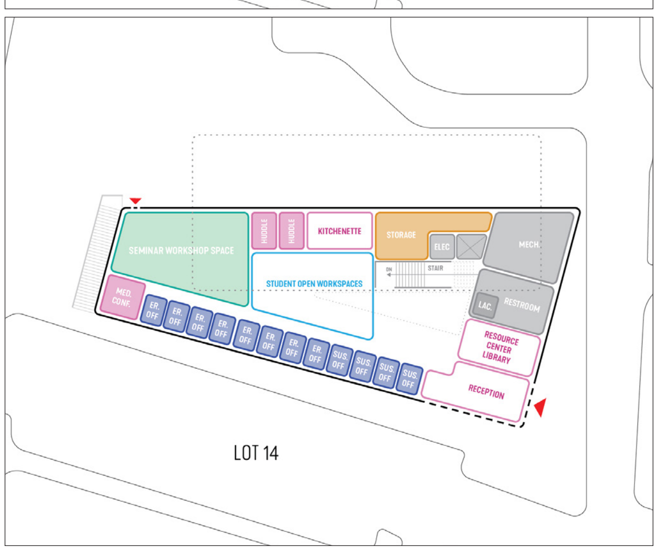
In order to validate the proposed space program, a departmental test-fit diagram was completed based on the "STRATIFIED" massing scenario (Figure 4.8.3). With priorities identified by the working group stakeholders during Visioning and Programming sections of this study the following planning concepts were derived:

Plan Test-Fit Option A – Key strategies of the detailed plan test fit explored in this option include: Level 1 Entry with reception and resource center library at the Southeast corner of the building with utility, restroom and service in the northeast. Offices along the south elevation with daylight and views towards the exterior and a medium-sized conference room next to the reception. Open workstations for students are located in the middle of the spaces adjacent to offices to the south and circulation east-west. The Seminar workshop space is located on the north side adjacent to the workstations/circulation. Level 2 program is accessible through th with elevator, electrical/IDF storage, north of stairwell to leverage central core.

Figure 4.5.1 - Functional stacking diagram Option A: Level 2 & Level 1



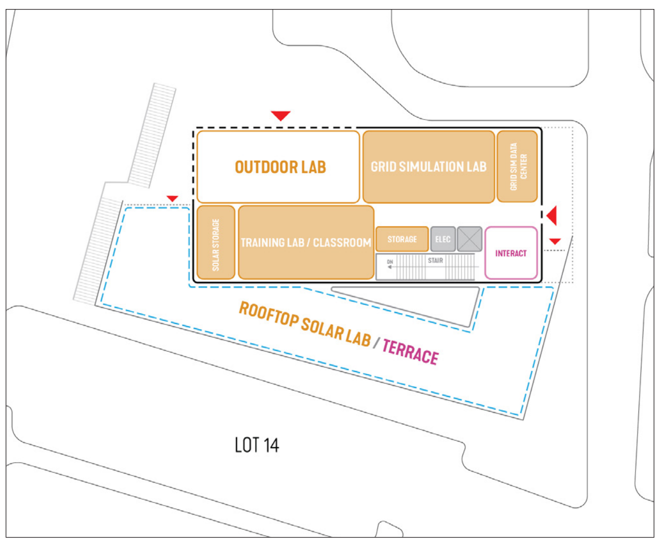
Level 2



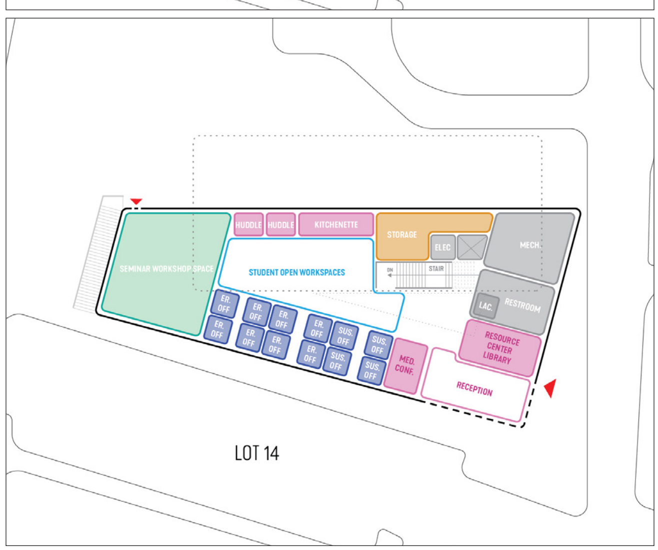
Level 1

Plan Test-Fit Option B - Similar to the above description test fit plans with the following key differences and variations: Level 1 staff offices are clustered along the south side, two deep so that daylight from the south is accessble via circulation corridors between offices to the central student workstation zone in the center. The Seminar Workshop Space is facing EAST towards B Street – providing a transparent face to campus to show collaboration along the campus entry sequence. The huddle rooms and kitchenettes have moved to the north side which has no windows, that accesses borrowed daylight from the clustered office approach. Level 2 program is accessible through and internal stairwell, which is the same as described in Option A.

Figure 4.5.2 - Functional stacking diagram Option B: Level 2 & Level 1



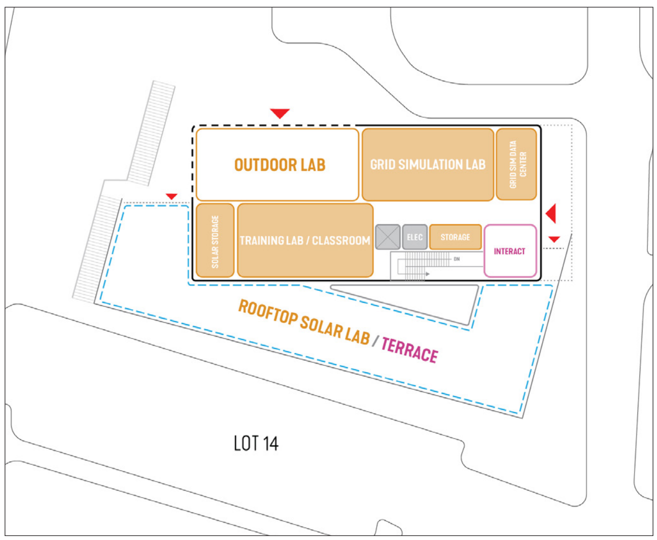
Level 2



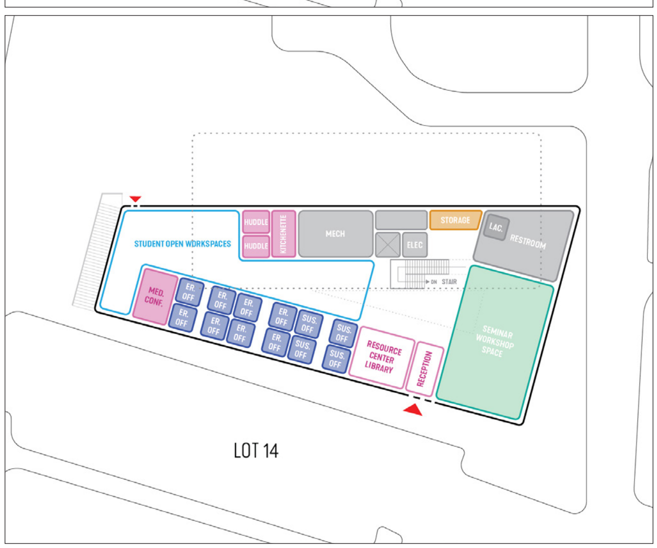
Level 1

Plan Test-Fit Option C - Key strategies of the detailed plan test fit explored in this option include: Level 1 Entry with reception, resource center library and Seminar Workshop space at anchoring Southeast corner as a welcoming face for public collaboration. Beyond the public area, an access control point to the Level 1 workspaces including the staff offices that are clustered along the south side, two deep so that daylight from the south is accessible via circulation corridors between offices to the central student workstation zone in the center and extends to the east, adjacent a medium-sized conference room, where views from campus can see the collaboration. The huddle rooms and kitchenettes have moved to the north side which has no windows, that accesses borrowed daylight from the clustered office approach. Level 2 program is accessible through and internal stairwell, which is the same as described in Option A.

Figure 4.5.3 - Functional stacking diagram Option C: Level 2 & Level 1



Level 2



Level 1

While Option C was the prevailing Test-Fit Concept Strategy at the end of the Feasiblity Study process that aligned best with the "Stratified" massing concept strategy, the working group expressed and interest in continuing the discourse about office configurations and public/private zones within the building. It was agreed that the above-mentioned studies would provide a valuable foundation for the progressive desigg-build team to explore further based on the established evaluation criteria framework that was developed with the working group during the feasibility study process.

Figure 4.5.4 - Functional stacking diagram Option C: Level 2

Level 2 ASF:	**4,591**
Level 2 Outdoor Ground Lab:	**1,980**
Total Level 2 ASF + Outdoor Lab:	**6,571**
Level 2 GSF + Outdoor Lab:	**9,632**

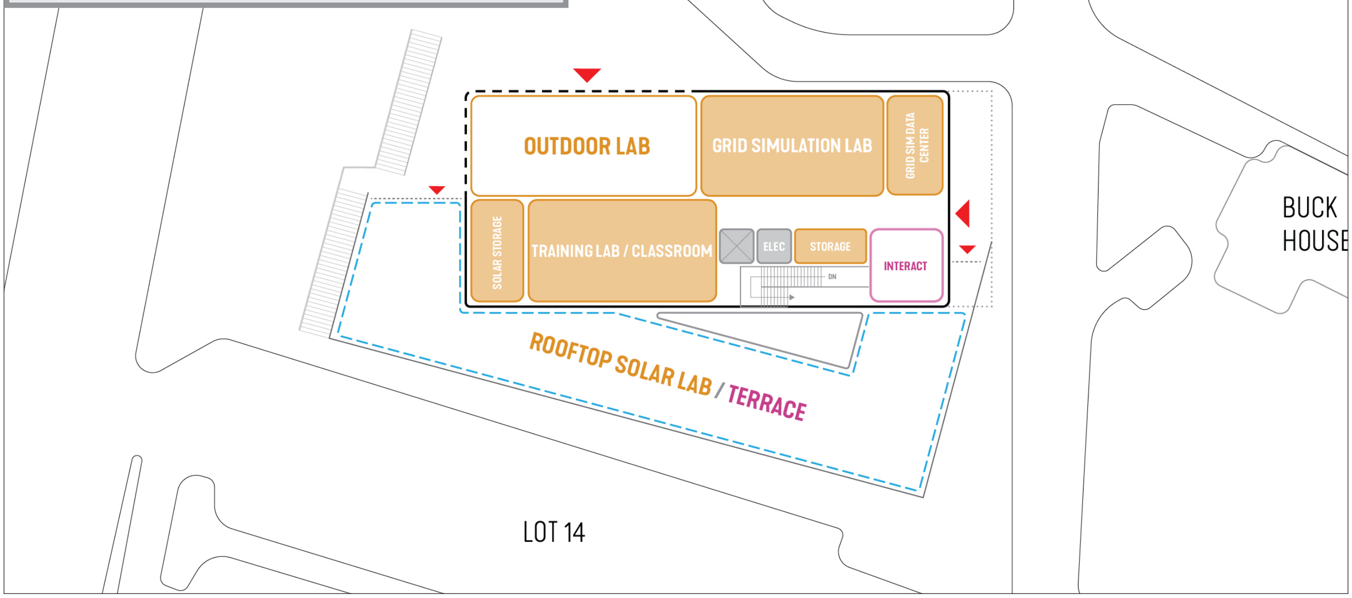
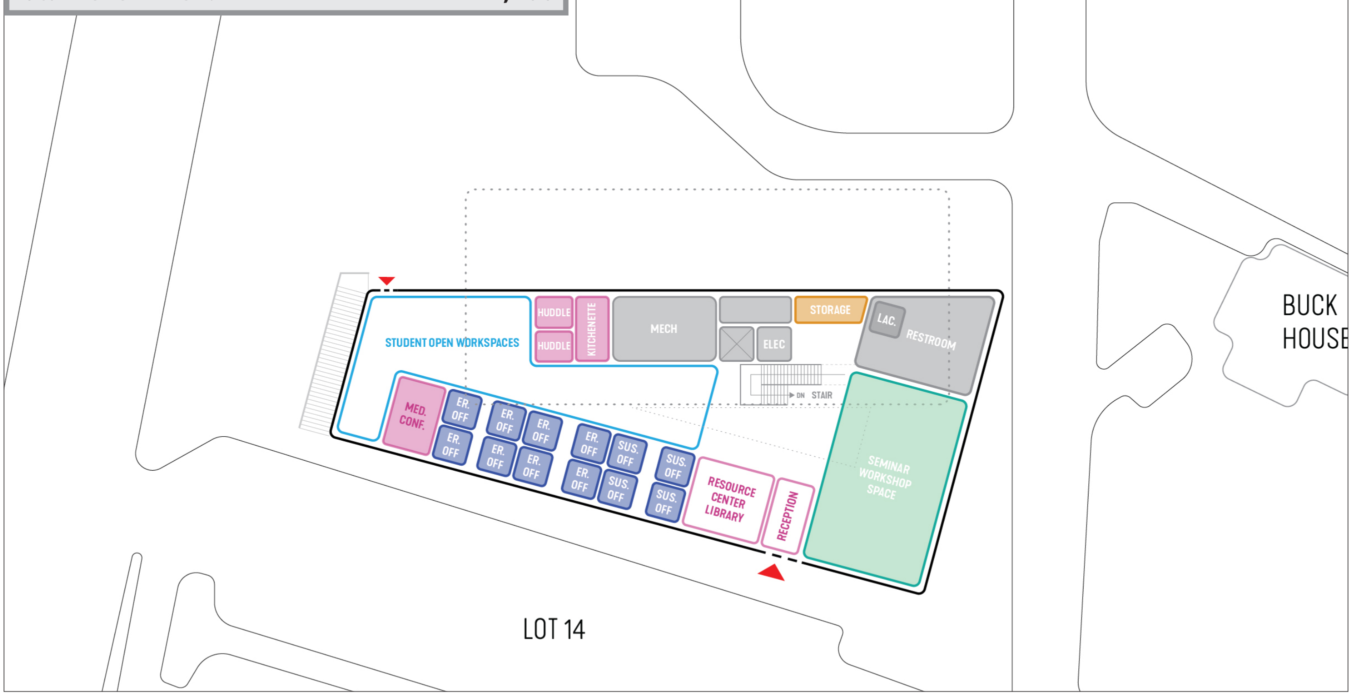


Figure 4.5.5 - Functional stacking diagram Option C: Level 1

Total Level 1 ASF:	**7,819**
Total Level 1 GSF:	**12,106**



Total ASF + Outdoor Lab:	**17,451**
Total GSF + Outdoor Lab:	**21,737**

Figure 4.5.6 - Functional stacking diagram Option C: Level 2

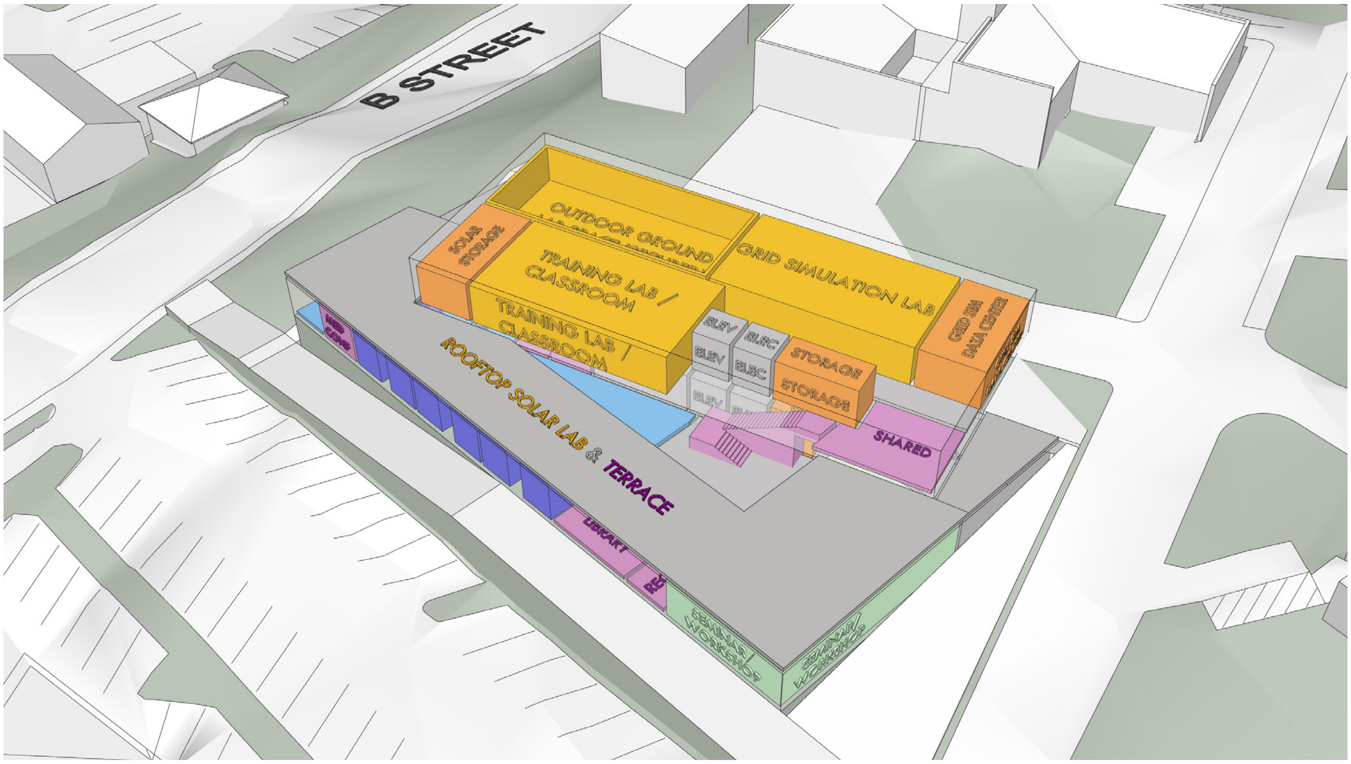


Figure 4.5.7 - Functional stacking diagram Option C: Level 1

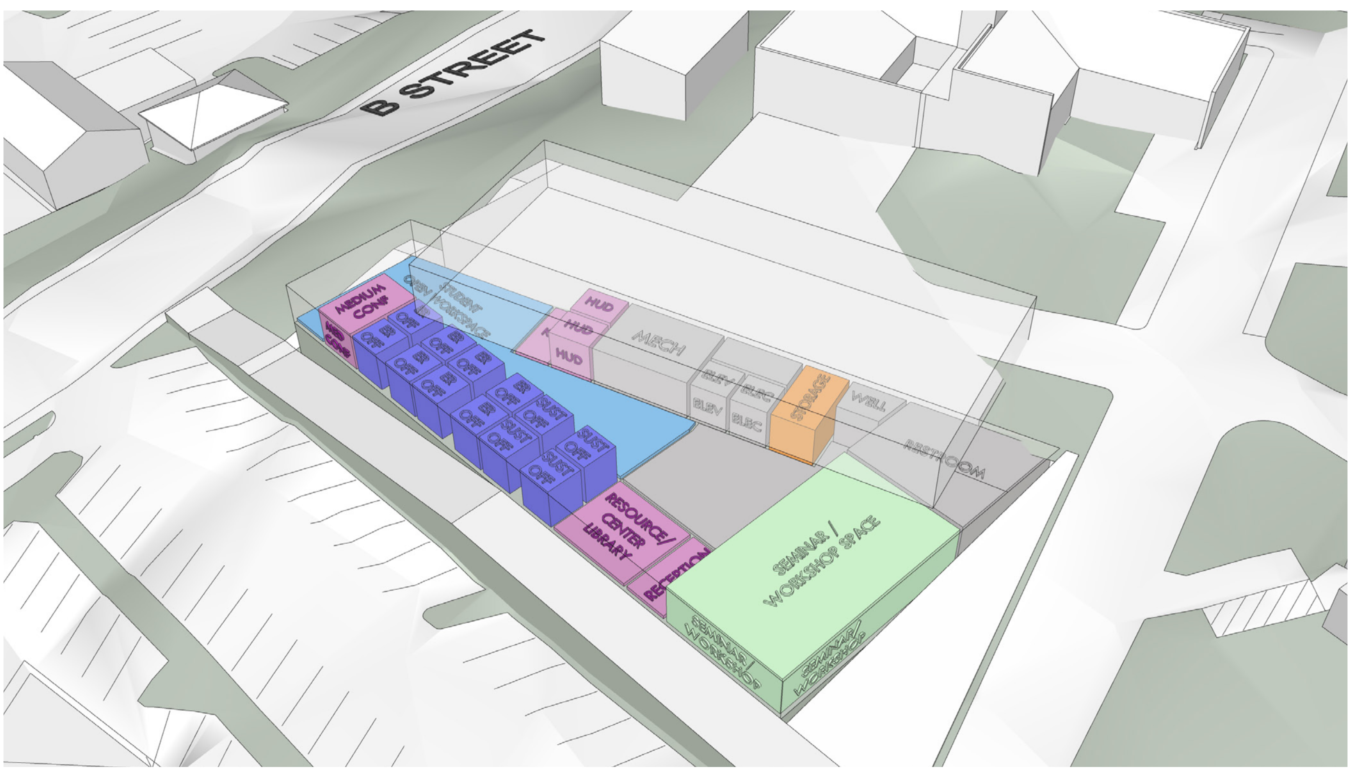


Figure 4.5.8 - Functional stacking diagram Option C: Cross Section

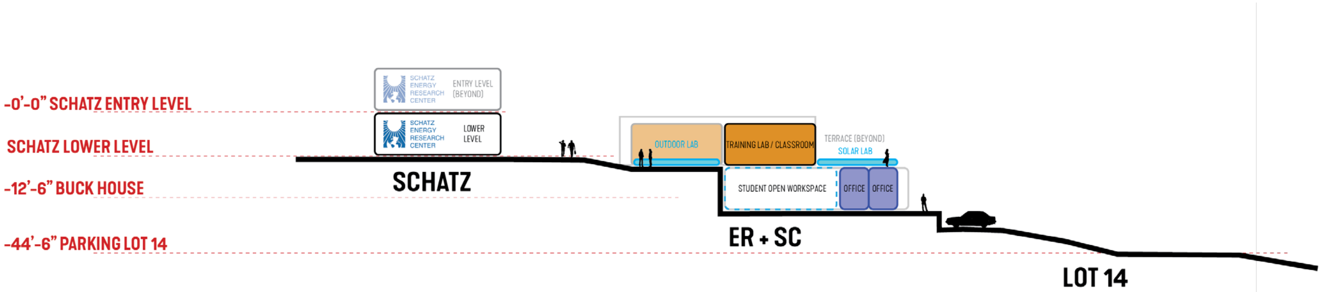
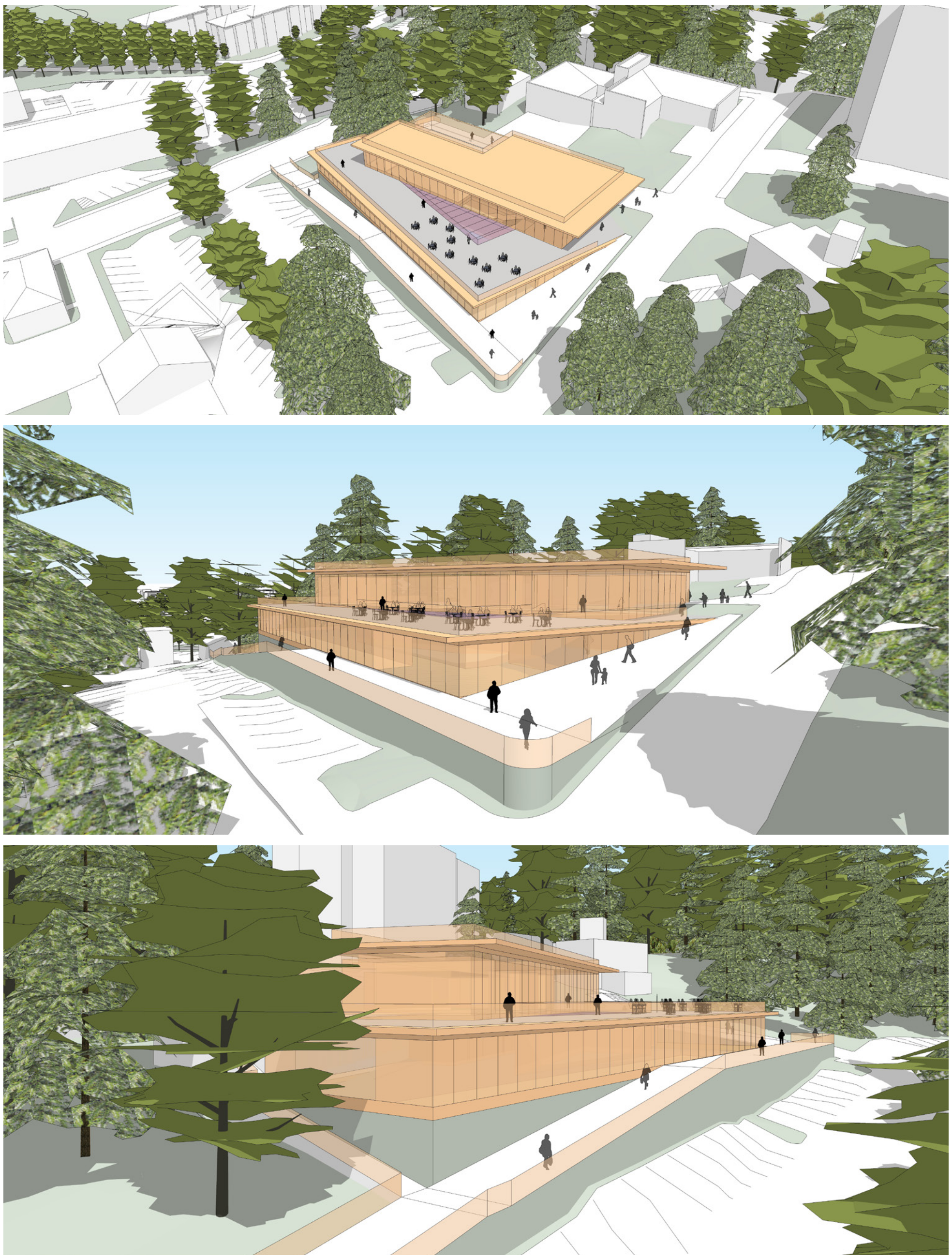


Figure 4.5.9 - Option C: Enclosure System and Exterior Spaces



05

BASIS OF DESIGN AND SYSTEMS APPROACH

5.1 LANDSCAPE

The landscape architecture design of the new Energy Research and Sustainability Center shall offer a beautiful, safe, accessible, and welcoming environment closely supporting the research, teaching, environmental, and sustainable elements on display at this new building—along with wellness and comfort of students, visitors, and staff. It should complement and reinforce the architectural character of the new building and will be cohesive with the 144-acre campus, downtown Arcata, and the Humboldt community. The term 'landscape' is inclusive of all non-building and non-vehicular paving portions of the site and includes planting areas. Planting will be provided throughout the perimeter of the site by means of tree lined streetscapes, along the new building foundation, and the on-structure exterior terrace. Refer to the civil engineering narrative for further discussion on infrastructure, grading, retaining walls, materials, water requirements, and other related aspects that are tied to the landscape.

Site circulation, views, and vistas for students, visitors, and staff, enhanced accessibility, access to green and respite open space, and a holistic approach around site life-cycle management shall be key elements to the site plan. The site plan should prioritize safety of all users and maximizes the visual and physical connection to nature. Access to all public portions of the site and building shall be provided in compliance with applicable codes. The landscape shall guide and reinforce site circulation with minimal conflict between vehicles and pedestrians. The design should also include sustainable and environmentally responsible features to the greatest extent possible, and if necessary to meet CALGreen Code requirements and LEED design credits. The landscape shall be compliant with ADA standards for accessible design, Water Efficient Landscape Ordinance (AB1881), as well as any other applicable governmental jurisdiction requirements that may be applicable to this site.

5.1.1 CONCEPTUAL DESIGN

The site design concept should aim to blend the building and the pedestrian experience into the existing landscape as seamlessly as possible--creating a weaving of sustainability and environmental understanding by design through compassion, collaboration, and connection to complement the tapestry of the Cal Poly Humboldt Campus. The landscape design should also support sustainability experiments that may take place outside the walls of the facility; these activities to be reviewed/discussed as part of final building design.

The following are key site components:

- **On Structure space**: An exterior terrace on the south facing 2nd floor provides an opportunity for a series of respite spaces that can accommodate small to large group gatherings. This terrace will also function as the centerpiece for sustainability where photovoltaic experiments will occur. The perimeter of this outdoor space could have fixed planters with native grasses that will not impede any of the photovoltaic projects. For flexible seating, moveable tables and chairs could be considered. Secure access to the terrace will be required.
- **Loading zone**: An expanded loading and parking area shall be provided at the Outdoor Lab. One van accessible parking stall will be provided. The accessible parking/loading zone may be shared with the Schatz Energy Research Center.
- **Streetscape**:Add planting strips to sidewalks along adjacent roadways to create a buffer between

pedestrians and vehicular drives.

- **Accessible pedestrian paths**: Seamlessly integrate ADA accessible pathways from nearby parking and most sidewalks to the entrances of the building. Where ramps are needed, ensure a clear and accessible connection from ramps to and from ADA parking in lot 14.
- **Nature Path:** A nature pathway may be considered with the goal of integrating existing natural elements, such as the adjacent redwood trees.
- **Existing trees**: Retain as many of the healthy tree specimens located on site as possible.

Safety of students, visitors, and staff is the top priority with the design of the landscape. The final design should incorporate the following goals:

1. A simple and clean planting palette will use a limited number of native species to meet the function of the landscape.
2. The landscape will be designed to be cohesive with the surrounding area and to reflect the unique culture and character of the campus.
3. The landscape will complement the architectural character of the building.
4. The design will provide various landscape areas that respond to the intended use of the site. Higher intensity landscape and hardscape elements such as site furnishings will be provided near the building entries, the exterior terrace, and site entries. Secondary landscape zones in key view areas such as street frontage and building perimeter will provide visual interest.
5. Accessible pedestrian paving will be provided at all public entries with emphasis on a pedestrian connection between the existing campus, parking, and the new building.
6. The design will provide enjoyable exterior spaces for students, visitors, and staff that is inclusive of seating areas with pleasant views.
7. Clear views will be maintained throughout the landscape areas for security and will provide defined access for pedestrians.
8. The planting design will provide visual relief using shape and color, plant form, and leaf color and texture in key areas, utilizing biophilic design interventions.
9. Unless specifically needed for screening, trees particularly along pedestrian walkways should be pruned up to provide a minimum of 7' from the ground to the underside of the canopy.
10. The design will utilize trees and other plantings to help mitigate the climate. Deciduous trees in the south and west facing building exposure will allow for solar gain and protection from wind in the winter and provide for cooler outdoor spaces in the summer.
11. Consider designing planting areas with shrubs, perennials, and groundcovers that will remain low to

maintain clear views throughout.

5.1.2 HARDSCAPE

Exterior hardscape shall be designed to be code-compliant and meet the functional needs of the site and the building. Materials and design shall be durable and long lasting, complementary to the building, lobby interior, greater campus, and provide clear and defined access. The hardscape will also conform to the forthcoming master plan and guidelines.

1. The design will provide code-compliant accessible concrete sidewalks and/or modular paving from public streets and accessible drop-off space to entries to the new building. Pedestrian walkways will be designed to minimize crossings between pedestrians and vehicles. At the drop off areas, vehicular paving may be modified to reinforce pedestrian use. Plantings shall be low in those areas to allow for visibility.
2. An outdoor patio area and terrace will have dual functions, whether for gathering or respite will be provided on the south side of the building. The paver assembly should conform to the forthcoming master plan, but the pavers shall be manufactured by a west coast entity such as StepStone, QCP, or ColdSpringUSA Granite, with the preferred pedestals being Bison.
3. Some sidewalks and paving areas may be designed to slope toward the planting areas instead of the curb and gutter to direct storm and irrigation run-off into planting areas instead of the storm drain.
4. At Drop-off areas, durable pavers could be used to differentiate between vehicular and pedestrian zones. If used, color of pavers should meet necessary SRI requirements for LEED and sustainable practices. Sidewalks shall be poured in place concrete with saw-cut joints. If used, Integral color selection will match the greater campus.
5. New perimeter pathways adjacent to the project site will be necessary. Due to site slopes, retaining walls adjacent to the pathways and buildings may be necessary in some areas.
6. The design should incorporate a pedestal paver system for the 2nd floor roof terrace.

5.1.3 FURNISHING

Site furnishings, where used should complement the historic campus context as well as the architectural style of the new building and conform to the forthcoming master plan and guidelines. Site furnishings such as benches, trash receptacles, and bike racks will be located at key areas to be used by employees and students. Sustainable materials, location of manufacturing facility in proximity to the university, and site appropriateness of materials are some of the factors that should be considered when choosing site furnishing

1. End of life and responsible disposal should be considered in selecting all furnishings. Fair trade and ethically made products (sweat shop free) should be prioritized.
2. All bench furnishings shall incorporate a back and arms to meet any accessibility code requirements or local guidelines.
3. Outdoor lighting shall be International Dark Sky (IDA) compliant. Select lighting products certified to

minimize glare, reduce light trespass, and help protect night sky.

4. Consider illuminated bollards at drop-off areas and other spaces where pedestrian-vehicular paths intersect.
5. Small landscape path lights may be considered at areas of respite in lieu of full-size lighted bollard.
6. A focal art feature could be considered in a planting area.
7. For flexible seating, moveable tables and chairs may be considered in at the south-facing outdoor roof terrace.
8. Manufacturer for fixed above-grade planters at the roof terrace includes Tournesol as Basis of Design.
9. Bike parking shall be incorporated in highly visible, accessible locations near entries at the new facility in accordance with state or local codes. Bike parking shall be covered and protected from the elements using building overhangs or other sustainable means and shall conform to LEED guidelines for both long- and short-term bike parking. The final quantity and types of bike parking should be coordinated with forthcoming campus standards.

5.1.4 PLANTING

The planting plan shall provide for an effective and functional landscape that meets the needs of the building and the rest of the campus, promotes safety, and uses relatively low water. Planting should complement the existing landscape while enhancing the character of the new building and reflecting the character of the campus. Plants will be selected from the campus Landscape Committee planting palette. Plants will be chosen to perform well and require the least amount of on-going maintenance and conform to the forthcoming master plan and guidelines.

1. Plant species that are appropriate for the climate, the site, and ease of maintenance will be utilized.
2. Plants will be selected and spaced at the time of planting to be appropriate for the intended use and their size at maturity. Selected plant species will provide for:
    a. A safe site with clear views.
    b. Reduction in maintenance hours associated with pruning.
    c. Better health of the plants.
    d. Reduction in generation of green waste.
3. Consider a palette of drought-tolerant / low-water using plants for reduction in irrigation demand.
4. Maximize use of California native plants that are resilient to climate related stressors and promote pollinator health. Using native plants minimizes or eliminates the need for synthetic fertilizers and pesticides.
5. Planting will be designed in hydrozones of similar water needs. The irrigation will be designed to comply with the planting hydrozones. Hydrozones will be based on plant water needs, sun

exposure, slope, and soil conditions.

6. A combination of ornamental and deciduous trees in informal massing to provide perimeter screening.
7. Trees will be planted away from light poles. The optimal lighting location will be coordinated with tree locations.
8. All planted landscape areas are to be covered with minimum 3" of bark mulch and, if flow through planters are required, will have a 3" lift of la paz stones 3" in diameter.
9. Lawn areas will be avoided unless they are needed to provide a functional use.
10. Plants shall be installed at sizes that are appropriate for the intended use and typical of planting techniques.
11. If used, trees will be planted at minimum 36" box size with a guying system such as the hidden platypus deadman guying system below surface, similar to: https://platipus.us/wp-content/uploads/2018/05/Platipus-Brochure-Tree-USA.pdf as Basis of Design
12. If used, specimen trees will be planted at 60"-72" box size with staking or guying.
13. If used, shrubs will be planted from 5-gallon and 1-gallon size containers and spaced as needed based on their mature size – typically 4' – 6' on center.
14. If used, groundcover will be planted from 1-gallon size containers and spaced as needed based on their mature size – typically 24" – 48" on center.
15. After mass grading and prior to planting, soil fertility test shall be performed from two-to-three areas of the site. Soil amendments, fertilizers, and ratio of mixture with the native soil shall be installed per the recommendations of that report.
16. Landscape may include edible fruits and berries, and medicinal plants in strategic locations.
17. Landscape should reflect regenerative soil practices, beneficial plan and pest relationships, and should be maintained with no chemical herbicides
18. Landscape will facilitate healthy insect and pollinator relationships.

5.1.5 IRRIGATION

The permanent irrigation system shall be designed for long-term function with quality components and for ease of maintenance. Irrigation to apply the optimal amount of water based on the needs of the plants. Plants will be placed in hydrozones based on their water use requirements, and the irrigation will be designed specific to those hydrozones.

1. Planting will be designed to meet the requirements of the city and the state-mandated Water Efficient Landscape Ordinance (WELO - AB 1881). This ordinance limits the amount of irrigation water that can be used based on site specific calculations to determine the maximum water allowance as well as minimum irrigation efficiencies.
2. Irrigation will be predominately drip emitters or bubblers at each plant for shrub and groundcover

areas.

3. Irrigation will be designed for no overspray onto hardscape.
4. Irrigation controller will be a smart controller that will automatically self-adjust based on real-time weather updates (via cellular update from the manufacturer or on-site weather station) or soil moisture sensors. The model and manufacturer are to match existing controllers and allow for integration into the sitewide irrigation system.
5. Quick couplers and isolation gate valves will be placed throughout the landscape areas per the direction of hospital maintenance staff.
6. All piping, including drip tubing is to be buried and not placed on the surface of the soil. Only emission devices, such as emitters or the top of pop-up sprinklers shall be on the surface.

5.1.6 DRAINAGE

All landscape areas to effectively drain and/or serve as storm water run-off filtration and storage areas. Bioswales will be incorporated throughout site where possible. Drainage shall also conform to the forthcoming master plan report. Refer to the civil engineering narrative for further discussion on drainage and stormwater management.

1. All landscape areas that are not designed for storm water filtration or storage shall have swales and/or drainage catch basins to drain excess water.
2. Catch basins and swales shall be provided adjacent to the building to move water away from the foundation.
3. When possible, use swales to move run-off in lieu of drainage piping.
4. Storm water shall not be allowed to puddle in any vehicular or pedestrian paving areas.
5. Swales and basins shall be designed as needed to filter, detain, or retain storm water run-off prior to entering the storm drain system.
6. Site sidewalks should be designed to slope toward landscape and away from curbs and gutter to the greatest extent possible with swales in the landscape to move water away from the walks.
7. Landscape drainage facilities will be constructed of durable materials such as NDS, Rainbird, ACCO or similar high-quality products.
8. Slopes shall be planted and/or covered with slope stabilization fabric to eliminate/minimize drainage erosion. Erosion control fabrics shall not contain plastics or petroleum of any kind.
9. If used, bioswale areas will incorporate various sized boulders and river rock.
10. Planting design for stormwater facilities shall follow the North Coast Stormwater Coalition Low Impact Development Recommended Plant List and any available campus planting lists pertaining to stormwater management.
11. Plantings that stabilize hillsides and prevent erosion will be promoted.

5.2 CIVIL ENGINEERING

Sherwood Design Engineers has evaluated the capacity of the utility infrastructure systems listed below to serve the planned Energy Research + Sustainability Center. In addition, some of the modifications that may be required to serve or accommodate the proposed building have been identified.

- Water supply.
- Wastewater collection, treatment and disposal.
- Stormwater management and control.

5.2.1 SITE CONDITIONS & CONSTRAINTS

5.2.1.1 EXISTING CONDITIONS

The planned Energy Research + Sustainability Center would occupy a mostly vacant site located between B Street on the west and Cluster Court on the east. The Schatz Energy Research Center driveway is located immediately north of the site and campus parking lot G14 (Lot G14) abuts it to the south. The only existing improvements are the Jensen House in the southeast corner, walkways and steps that connect the house to Cluster Court and the adjacent parking, bike racks on a concrete pad next to Cluster and the Schatz Center driveway, and a gravel drive that runs west across the site from Cluster. This drive bends south before reaching B Street and transitions into an asphalt path that connects to the west end of Lot G14.

The remainder of the site consists of open lawn and many mature redwoods. A 2015 survey of the site by Kelly-O'Hern Associates indicates there is an existing transformer on a concrete pad just east of where the gravel driveway turns south and becomes an asphalt path. The survey also shows a line of three catch basins running along the east side of the path, roughly coinciding with what the campus electric facilities map indicates are "bases without poles." It is unknown if these poles exist or if any underground conduits connected to this transformer would conflict with the Energy Research + Sustainability Center project.

The following sections provide additional information obtained from both the Kelly-O'Hern survey and the campus utility maps. Prior to finalizing any plans for the installation of utility improvements to serve the Energy Research + Sustainability Center project, on-site surveys should be performed as required to confirm the extent and condition of all existing utilities.

5.2.1.2 DEMOLITION

Construction of the Energy Research + Sustainability Center as currently planned would require removal of the Jensen House and associated walks, the bike racks and pad, the gravel drive, and approximately thirty trees. The asphalt path and transformer appear to be outside the current building footprint.

In addition to the storm drain and electric facilities described in the previous subsection, the landscaped portions of the site also contain some abandoned, small diameter sewer and storm drain lines, as well as a number of what appear on the utility maps to be irrigation lines. These facilities would have to be completely removed within any areas proposed for building construction. See the following sections for descriptions of additional existing sewer and storm drain pipes on the project site that are assumed to still be in service.

5.2.1.3 SITE GRADING & DRAINAGE

The project site falls from north to south at an approximately 16 percent slope. It parallels the fall of the adjacent Cluster Court, except the on-site terrain is considerably more undulating, with steeper and flatter sections around the Jensen House and within the trees on the east side. The site falls more gently from east to west, although a significant portion of this fall occurs as a steep, unsupported bank that rises 8 feet to 10 feet above the B Street sidewalk. Existing drainage patterns follow the terrain, with almost all runoff ending up in Praking Lot G14 to the south. At this point it is collected by existing catch basins in the parking lot, except for a small area of pavement at the west end of the lot that drains out to B Street.

Plans now call for the building to be set into the existing slope, with the lower floor situated about five feet above Lot G14 and the upper floor two to three feet below the Energy Research + Sustainability Center driveway. It may be possible to provide a nearly level connection between Cluster Court and the lower floor at the east end of the building, but, because Cluster is so steep, it is more likely an accessible route into the building would have to be provided into the building from Lot G14 and/or from the Schatz Center driveway. In either case, it is expected ramps would be required to make the necessary grade transitions.

5.2.2 WATER SUPPLY

Water is provided to the Cal Poly Humboldt campus by the City of Arcata, which currently obtains all of its supply from the Humboldt Bay Municipal Water District (HBMWD), but also has a currently off-line groundwater well with a capacity of 182 million gallons per year. In 2020, the City [1] used approximately 50% of its 1186 acre feet (386 million gallons) annual allotment from HBMWD, and projects this will rise to 63% by 2045. Because the City's demand projections include the anticipated growth of the community (which includes the Cal Poly Humboldt campus), it is not expected that supply constraints would affect the City's ability to serve the campus in either the short or long term. However, continued campus development could potentially affect the City's local storage facilities, which it maintains to meet peak domestic and fire flow demands. As a result, the City Engineer has indicated they would like the campus to provide advance notice of all planned increases in demand so the collective impact of ongoing development throughout the City's service area on both storage and distribution facilities can be fully evaluated.

Water is delivered to Cal Poly Humboldt through a City distribution system that abuts the campus on three adjacent roadways; LK Wood Boulevard, 14th Street and Union Street. In addition, a large diameter water main cuts across the campus on Harpst Street, B Street and 17th Street, connecting main water lines on LK Wood Boulevard and Union Street. The B Street main also runs south to connect with the main on 14th Street, and continues north past Harpst Street to a dead end near the middle of the Student and Business Services building. This network of pipelines provides several points of connection between the City and the campus distribution system, which delivers water to all existing campus buildings and facilities. There is no separate fire system. Both potable and fire suppression supplies, including building

1 For the purposes of this study, if "City" is used by itself, it is intended to mean the "City of Arcata" and or the "City of Arcata's" officials and departments.

sprinklers and fire hydrants, are supplied by the same distribution system.

Maps of the campus distribution system show an existing 10" campus water main running south on Cluster Court from just north of the Behavioral and Social Sciences building. This main ends on the map approximately 65 feet north of the project site, so it is estimated a 6" water line would have to be extended south in Cluster Court to serve the Energy Research+Sustainability Center building's anticipated 1075 gpm demand (100 gpm domestic; 225 gpm fire sprinklers; 750 gpm fire standpipe). Alternatively, a new line could be extended east from an 8" water main on B Street, but it would have to run through an area of mature trees located outside the currently planned Energy Research+Sustainability Center building footprint and then cut through the steep bank that separates the project site from B Street.

There are two existing fire hydrants in the project vicinity, one located on Cluster Court adjacent to the stairs into the Behavioral + Social Sciences building and one on B Street adjacent to the driveway for the Facilities Management parking lot. According to the conceptual layout, all parts of the planned Energy Research+Sustainability Center building would be within a 250 foot hose pull from one of these hydrants. This is consistent with California Fire Code standards, so if this maximum pull distance is not exceeded as the building design evolves, new hydrants (and possible water line extensions, depending on hydrant location) would not be required. It is noted, though, the State Fire Marshal will make the final determination regarding both fire flow and fire hydrant spacing requirements for the planned building.

5.2.3 WASTE WATER COLLECTION, TREATMENT AND DISPOSAL

The City of Arcata treats and disposes of all campus wastewater in the City's wastewater treatment facility located adjacent to the north end of Humboldt Bay. The facility includes the Arcata Marsh Wildlife Sanctuary, which provides enhanced treatment for the secondary treated effluent from the treatment plant's oxidation ponds. Overflow from the ponds is discharged to Humboldt Bay in accordance with the City's National Pollutant Discharge Elimination System operating permit.

The City is currently upgrading the treatment facility, primarily to address numerous recent discharge violations. These violations mainly concerned the quality of effluent being discharged to the Bay, so the upgrades are focused on improving the facility's treatment processes, rather than increasing treatment capacity. Once complete, the facility will be able to treat a design average day flow of 2.3 million gallons per day (mgd) in accordance with the water quality requirements set forth in the operating permit. This flow rate, along with a 5.9 mgd peak wet weather flow capacity, was established in 2017, and both reflected a 20% increase over existing rates to accommodate build-out of the City's General Plan. Because this improvement program is underway, the Energy Research+Sustainability Center building's estimated wastewater generation of 5000 gallons per day should not affect the City's ability to comply with all discharge requirements, although the City Engineer would like to be kept informed of any campus development plans that entail increased wastewater production.

Wastewater is conveyed to the treatment facility through the City's collection system, which campus utility maps indicate abuts the campus on LK Wood Boulevard, 14th Street, a portion of Union Street, and on a walkway that connects the south end of Rossow Street to 14th Street. In addition, City sewer lines also extend into the campus in several other locations north of the Energy Research+Sustainability Center building site. The closest City sewer to the planned Energy Research+Sustainability Center building is on 14th Street, where it connects with a 6" campus line that runs north to the end of Cluster Court to serve the Jensen House, Buck House and the Schatz Center (a mapped service to the east end of the Behavioral and Social Sciences building is marked as abandoned). The sewer lateral for the Schatz Center runs across the northeast corner of the Energy Research+Sustainability Center site and would conflict with the currently planned building footprint. This lateral would have to be rerouted, most likely across the lawn in front of Schatz Center or through the driveway that connects the building to Cluster Court.

The campus sewer maps do not provide a depth for the Cluster Court sewer, but sewer lines in steep streets are typically not installed deeper than minimum cover requirements. As a result, a service lateral for the lower level of the Energy Research+Sustainability Center building would most likely have to connect to this sewer just north of the building's southeast corner, where current plans indicate the finished floor elevation will be roughly level with Cluster Court. However, it is recommended the depth of the Cluster Court sewer be field verified prior to finalizing the location of any building sewer laterals.

If the 6" Cluster Court sewer follows the grade of the overlying pavement between the site and 14th Street (which is considerably flatter than alongside the project site), it should have a conservative (half-full) flow capacity of about 450 gpm. It is expected this is more than enough to carry existing upstream flows plus peak wastewater discharges from the planned building's restrooms and labs. This assumption would need to be confirmed by the Energy Research+Sustainability Center building designers, though, to ensure sufficient capacity exists all the way to the Cluster Court connection into the City's sewer system on 14th Street.

5.2.4 STORMWATER MANAGEMENT

5.2.4.1 STORM DRAIN INFRASTRUCTURE

Stormwater runoff on the Cal Poly Humboldt campus is routed through a network of on-site collection pipes that drain most of the central campus. The principal outlet for these pipes is a large diameter City of Arcata storm drain that extends north from 14th Street along Rossow Street and B Street into the campus, and ends a short distance north of the Campus Events Field. The portion of the campus located south of the Natural Resources and Forestry buildings (which includes the project site) are located downslope of the City's B Street system, so campus piping for these areas drains to a 12" City storm drain that runs from east to west in 14th Street.

Downstream of the campus, the 14th Street storm drain discharges into a Caltrans culvert that runs south in the median of Highway 101 from a beginning point underneath the G Street overpass. This culvert carries most of the campus runoff, including some areas located south of Plaza Drive along LK Wood Boulevard that drain into City storm drains that discharge directly to the highway. Most runoff from the north end of the campus flows west into the Jolly Giant Creek culvert that crosses Highway 101 on the north side of Sunset Avenue and continues west into Shay Park and the open channel continuation of Jolly Giant Creek. The highway culvert that serves the City's 14th Street storm drain continues south in the median to just north of 7th Street, where it shifts west outside the Caltrans right of way. It then crosses 7th Street and discharges into an open channel that eventually makes its way to a network of slough channels within a wetland located between Samoa Boulevard, G Street and Highway 101. Pipes carry runoff from the wetland underneath G Street and the Northwestern Pacific Railroad to a final junction with Butcher Slough at the north end of Humboldt Bay.

Campus utility maps indicate stormwater runoff from the Cluster Court drainage area, which includes the Native American Forum, the south side of the Behavioral and Social Sciences building, the Schatz Center and parking Lot G15, is collected in a network of 6" and 8" diameter pipes. These pipes converge into a single 8" Cluster Court storm drain that gradually increases to 10" and then 12" as it passes through parking lot G15. This system discharges into a catch basin on 14th Street, between Union Street and the Lot G15 driveway. Because the project site slopes away from Cluster, runoff from both the site and Lot G14 flows through 8" and then 10" diameter pipes across B Street and through the Facilities Management parking lot, to an eventual connection with the City's 14th Street storm drain a short distance east of B Street.

The utility maps, also show a small diameter storm drain that begins at the Schatz Center and picks up runoff from two driveway catch basins, and then ends at the north edge of the planned Energy Research+Sustainability Center building site. It is assumed this line either continues in a southeasterly direction across the site to a connection with the existing 8" storm drain on Cluster Court, or it turns southwest and cuts across the western half of the site to connect with a catch basin in Lot G14. In either case, it appears the existing pipe runs through the currently planned Energy Research+Sustainability Center building footprint, so a new discharge would be needed. The simplest option would be to intercept the existing pipe just downstream of the Schatz Center driveway catch basins and install a connection to an existing Cluster Court catch basin located just south of the Buck House Driveway.

Because the Energy Research+Sustainability Center site slopes from north to south, stormwater management facilities described in the following sections would likely have to be located near or immediately adjacent to Lot G14, south of the Jensen House, although roof runoff could potentially be piped into a facility at the top of the site. Discharges from management facilities located close to Cluster Court could feasibly be connected to the existing 8" storm drain, but since the parking lot slopes away from Cluster, most facilities would probably have to be connected to the existing parking lot catch basins near B Street, in the eastern portion of Lot G14.

5.2.4.2 STORMWATER CONTROL

The City Engineer has indicated the existing storm drain system serving the campus has adequate capacity to convey peak rates of existing stormwater runoff to Humboldt Bay[2]. To ensure this capability is not compromised, the City would require any projects that might increase runoff (by increasing the area covered by impervious surfaces) to mitigate potential impacts on downstream piping systems by limiting the rate of post-development discharge to the rate under predevelopment conditions. This is typically

2 A Caltrans representative was not able to comment on development-related drainage issues that may affect Highway 101 infrastructure until they can be evaluated as part of the CEQA review process. However, it is expected that implementation of the City discharge limitations described in this section will prevent project development from adversely affecting the capacity of the highway culverts that receive runoff from the campus through the City storm drain system.

accomplished by detaining a portion of a storm's runoff until the period of peak rainfall has passed and the capacity of downstream facilities is no longer at risk of being exceeded. For the proposed project, it is estimated this would require approximately 310 cubic feet (2320 gallons) of storage to fully attenuate

the peak flow increase associated with a 10-year recurrence interval storm.[3] This would be typically be achieved through installation of buried storage (such as empty culverts, stormwater chambers and/ or gravel beds) or else by routing the runoff into a modified bioretention facility, as described in Section 5.2.4.3 below. For any of these options, constraints caused by existing trees the campus may want to preserve could limit the areas in which such facilities can be located.

5.2.4.3 WATER QUALITY PROTECTION

In addition to the City's requirement to control post-construction peak discharge rates, the building project would also have to comply with applicable provisions of the National Pollutant Discharge Elimination System (NPDES) Small Municipal Separate Storm Sewer Systems (MS4s) General Permit, as administered by the State Water Resources Control Board. The principal goal of this permit is to prohibit the discharge of contaminants by proposed development projects into downstream water bodies, both during construction and after the project is completed. For construction, the Energy Research+Sustainability Center development team would have to prepare a Stormwater Pollution Prevention Plan (SWPPP) for implementation by the general contractor. These plans typically focus on preventing sediment from entering storm drain facilities that will carry it into streams or other downstream receiving waters. This is mainly accomplished by not disturbing natural areas until they are ready to be developed, stabilizing disturbed slopes immediately after grading is complete, and filtering or impounding sediment-laden runoff until it can be safely released.

Per the MS4 permit, post-construction pollution controls must be designed to trap the contaminants that accumulate on impervious surfaces and are washed into stormwater runoff. This is achieved by retaining on site the "first flush" of all impervious surface runoff (retained stormwater is never discharged, whereas detained stormwater, as discussed in the previous subsection, is only held temporarily). In the north coast region, the first flush includes all runoff generated by storms up to and including the 85th percentile rainfall event, which, around Humboldt Bay, equals 0.65" of rain. As currently planned, there will be approximately 18,500 square feet (sf) of impervious surfaces (17,200 sf building; 1,300 sf site paving) on the Energy Research+Sustainability Center building site. These areas would generate just over 1,000 cubic feet of runoff in the design rainfall event.

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3 Pre and post project runoff rates were calculated using the Soils and Conservation Service TR-55 methodology and a 24 hour rainfall total of 4.68 inches. Impervious areas were assigned a Runoff Curve number of 98, and pervious areas a number of 74 (good grass cover over Type C soils was assumed). When this data, along with pre and post project estimates of impervious cover, was inserted into a hydrologic model, it was determined approximately 245 cubic feet of runoff would have to be detained to maintain discharge rates no higher than under existing conditions. This volume was then increased by 25% to allow for inefficiencies that typically occur when routing stormwater runoff through detention facilities.

Since there are no opportunities for recycling captured runoff on campus, and no current plans for reuse within the building, stormwater can only be retained by infiltration into the ground. The project geotechnical investigation (SHN Consulting Engineers and Geologists, Nov. 2015) did not address percolation rates within the site's native soils (characterized as sandy silt and silty sands), so it is unknown if rates are too low to support infiltration. If they are, and in the absence of other retention options, the Regional

Water Quality Control Board would permit the runoff to be slowly discharged to Humboldt Bay through the local storm drain system. If this is a permitted option, the full 1,000 cubic feet of retention storage would not be required. The project would still have to provide the detention storage discussed in Subsection 5.3.1b, but the biotreatment facility(ies) described below would only be required to include a 12" gravel storage layer below the upper layer of filtration soils.

In order to protect the quality of both groundwater (in the case of infiltrated runoff) orand surface waters (in the case of slowly released runoff), the first flush of runoff would first have to flow through a biotreatment facility[4] to remove contaminants. Per sizing criteria set forth in the Humboldt Low Impact Development Stormwater Manual, such facilities must have a surface area equal to no less than 4% of the impervious area being treated. For the estimated 18,500 sf of impervious surfaces on the Energy Research+Sustainability Center building site, this would require an approximately 740 sf biotreatment facility. Although relatively small (approximately 27 feet x 27 feet in total area, which would likely be divided into multiple biotreatment basins), it appears that previously described constraints associated with existing trees, as well as the site's steep topography, may limit the areas in which such a facility could be constructed. As a result, the scope and extent of water quality protection facilities that would ultimately be required should be identified early in the site design process to ensure they can be accommodated within the final development footprint. In addition, to better comply with the site design provisions of the Humboldt Low Impact Development Manual, these facilities should be integrated with the surrounding landscape wherever possible to mimic natural patterns of flow and maximize the incorporation of green infrastructure into project open spaces.

4 Biotreatment refers to the contaminant removal achieved by filtering runoff through a layer of soil and organic material, whereas a bioretention facility combines biotreatment with a gravel reservoir that holds the runoff until it can infiltrate into the ground. If the runoff simply passes through the soil and gravel prior to discharge, so little or nothing is "retained," it is more accurately referred to as a biotreatment facility.

5.3 ARCHITECTURAL

5.3.1 EXTERIOR CLADDING

The exterior skin system for the planned building will be durable, water-resistant, compatible with the surrounding context, cost-effective and appropriate for the intended use. Exterior materials and systems selection should consider waste streams and LEED when being selected. Systems are to be installed in alignment per industry best practices.

Several types of materials and window systems are available within varying cost allowances and different materials will be analyzed for their cost effectiveness to meet the budget. The final choice of systems will be made during the Schematic Design phase of work. Contrast and texture in the use of exterior materials will be studied carefully for visual interest and for the relationship to the interior function of the building. Careful attention will be given to avoid water and moisture intrusion at areas where different materials or building systems are joined, such as at exterior windows and door conditions. The minimum R-value for exterior walls will be R-19. If using rain-screen type cladding systems, preference will be given to systems that can work with non-metallic support systems.

Metal flashings at walls and openings shall be made from stainless steel to maximize the longevity of system. Stainless steel flashing shall be provided at grade to conceal exposed slab edges and to cover transitions of subgrade waterproofing to vertical surface vapor barrier transitions.

Glazing will be utilized to provide natural light into the occupied building areas and to provide views outwards into the surrounding campus. Sun shading, screening and glazing types will be studied to limit the effects of undesirable heat gain and visual glare. The window system may be painted aluminum, structural curtain wall, or other appropriate quality system and will be investigated during design. In parts of the façade, smaller punched openings may be developed where less light is required within the adjacent spaces. Careful consideration will be given to the location of exterior windows with respect to maximizing daylight, possible furniture locations, and final locations of specialty equipment.

At exterior door entries, canopies or recessed entries will provide the necessary protection for inclement weather. The features at the entries, canopy or other, should also be used to give the building presence and as a way-finding tool.

5.3.2 ROOFING & WATERPROOFING

The selection of roofing systems will be considered to reduce heat island effect and to limit glare if visible from occupied spaces. The roofing system will also be selected to withstand the long-term effects of sun, wind and rain, and to accommodate on-going roofing maintenance and eventual replacement. All fasteners and flashings shall be of stainless steel to maximize longevity of the system, unless the flashings and fasteners are specifically part of the warrantable roofing system itself. Roofing color and material may be considered so to compliment the existing campus aesthetic.

The roofing system will provide thermal insulation having a minimum value of R-30. If making use of low-sloped roofing, among acceptable roofing membranes are PVC, EPDM and Multi-Ply SBS-Modified Bitumen Membrane systems and minimum slope shall be 2% minimum at the valley of any low sloped roof. Other roofing materials may be considered depending on the final design and will need to be reviewed with the University. Performance criteria is a minimum and shall be designed per Code and University requirements.

Figure 5.3.1 Glass Simple Comparison

In schematic design, the locations of the air-handling units and exhaust fans will be studied - if located on the roof, the will be installed with vibration isolation. Exposed, roof-mounted equipment will be located behind a parapet wall or equipment screen made of durable materials to withstand the environment, screened from view and kept to a minimum. Roof screens structural systems shall have be hot-dipped galvanized at all surfaces. Roof-mounted equipment will be grouped together and rest upon common curbs to the extent possible. The rooftop equipment shall be well organized visually and functionally. Roof penetrations for piping and ductwork will be minimized and appropriately detailed. The roof area will be evaluated for its potential to accommodate photovoltaic (PV) panel arrays.

- Where different waterproofing and weatherproofing systems meet, details shall be reviewed by manufacturers and ensured to be warrantable.
- Below grade waterproofing at the retaining walls and slab on grade shall be designed so to prevent a build-up of water at the earthen sides of structure.

5.3.3 STAIRS & ELEVATOR

Stairs (if required) and elevator will be located to maximize flexibility for future internal space changes and to comply with the building's exiting requirements. Stairs and elevators shall be designed to meet all applicable standards and codes, particularly the Americans with Disabilities Act.

5.3.3.1 STAIRS

The building is sited on a sloping site where portions of each floor level are expected to meet at grade at both floor levels such that sufficiently spaced exits can be provided without requiring dedicated egress stairs. The building is not expected to required interior egress stairs. The building is planned to have an interior convenience stair to aid in visual connection and interaction among the building's occupants that may not be required for egress, but shall be designed to meet accessibility.

Roof access shall be through a conveniently located yet secure roof hatch accessible from a back-of-house space.

5.3.3.2 ELEVATOR

The building is expected to have a single elevator. It is intended that this elevator serve both passengers as well as movement of delivery of materials within the building. The elevator will not provide service to the roof. The elevator will be machine room less (MRL) type unit and shall conform to accessibility requirements.

5.3.4 GLAZING

A key indicator of excellent glass is the ratio of light transmission to the solar heat gained. The more Light to Solar Gain (LSG), the better. Solarban 72 on Starphire glass is an example of industry leading high performance glass, with a VLT of 0.71 and an SHGC of 0.30. This resultant LSG of 2.37 is unparalleled by other glass types, and is the most visually clear double pane low-e IGU currently available.

While the final glazing specification may be driven more by the SHGC requirement than the VLT, choosing a glass type that achieves a LSG of at least 2.1 is recommended.

All partitions shall be finished with gypsum board to a smooth finish (Level 4), ready for paint. Storage rooms and building support spaces shall be finished in a light texture (Level 3) and ready for paint. Above finished ceilings and at concealed spaces a fire-taped level of finish is acceptable. All gypsum board wall surfaces exposed to view shall be painted. Where ceramic tile, concrete, concrete unit masonry or metal surfaces occur, those surfaces may be left unpainted and their natural finish exposed. Latex enamel interior paint with a satin finish will be the typical paint used at partitions.

5.3.6.3 CEILINGS

Finished ceilings may not be appropriate for all spaces and will be omitted where a ceiling system is neither necessary nor desirable. Finished ceilings may be omitted for aesthetic effect in public areas such as the building lobby, office areas, or possibly some laboratories. Consideration will be given to the nature of adjacent spaces when determining whether the finish ceiling may be omitted. Finished ceilings will be provided in utility spaces that adjoin and may be visible on a regular basis from high profile public areas.

Acoustics in the areas where open ceilings occur will be studied to achieve appropriate sound levels. Finished ceilings will be omitted in mechanical rooms, electrical rooms, telephone/data room, and other similar spaces.

Where the control of noise or vibration is necessary, the ceiling design may be required to include aditional layers of gypsum board, 3-1/2" acoustical batt insulation laid above the ceiling, and/or vibration isolated hanger devices.

Gypsum board ceilings shall be installed primarily in toilets, locker rooms and showers, and other areas where there will be exposure to water vapor. Gypsum board ceilings shall also be installed as required to control noise and vibration in spaces with high levels of equipment or fixture-generated noise or where aesthetic effects are warranted. All gypsum board ceilings shall be constructed with ceiling framing independent of walls and columns and be attached with resilient channels or resilient hangers to the structure above. All joints between floors, walls, and ceilings shall have an acoustic seal.

Gypsum board ceilings in spaces with little to no exposure to water vapor, such as public areas, offices, or other similar spaces where gypsum board is used solely for noise control or aesthetic effect, shall be constructed with standard gypsum board. Standard gypsum board shall be 5/8" thick and comply with the requirements of ASTM C36.

Gypsum board used on ceilings shall be finished smooth (Level 4), ready for paint. Satin finish, latex enamel interior paint shall be applied to ceilings in general use spaces where there is little or no exposure to vapor. Semi-gloss finish, latex enamel interior paint shall be applied to ceilings in areas with low to moderate exposure to vapor. Semi-gloss finish, alkyd enamel paint shall be applied to ceiling above showers and other spaces with high exposure to water vapor.

Exposed structure with concrete elements, structural steel elements, and metal deck exposed to view

may be painted or left unfinished as appropriate for aesthetic effect. It should be considered when exposing mechanical, electrical and plumbing systems as well that all exposed items meet the desired aesthetic where such materials may be exposed to public view.

5.3.6.4 INTERIOR FABRIC SHADES

Where shades are provided, shades shall be manually controlled. Where shades are used and placed at heights not accessible by all building occupants, motorized shades are to be considered.

If a fabric shade system is pursued, the following shade fabric specifications to maximize performance shall be met:

- PVC-free shade cloth material
- Medium to light grey or medium-light tone in color (avoid whites that become too bright when struck by direct sun, and avoid dark colors and black that do not diffuse sufficient ambient daylight into the space when struck by direct sun).
- 1% openness factor on east and west facades
- 3% openness factor on south facade
- 5% openness factor on north façade

5.4 STRUCTURAL

5.4.1 PROJECT DESCRIPTION

The proposed Energy Research and Sustainability Center will be approximately 22,000 gross square feet. This new facility will be a two-story building. The building is sited on a sloped hillside and the upper portion sits on grade while the downhill side of the building is set into the hillside. The building houses an outdoor research laboratory for microgrids research and the balance of the facility has classroom and meeting space.

Floor to Floor heights are assumed to be:

Upper Hill Story:	16 feet above grade.
Down Hill Facility:	16 feet below grade

Foundations

A geotechnical report is not available for this site. However, a geotechnical investigation was performed in 2015 by SHN Consulting Engineers & Geologists, Inc. for the Schatz Energy Research Center Addition and this facility is in close proximity to our site. Based on this report the foundation system recommendation for this project should be a shallow bearing foundation with the following properties:

D+L Allowable Bearing Pressure:	2,000 psf
D+L+E (W):	2,660 psf
Friction Coefficient:	0.35
Passive Pressure:	170 pcf
Retaining Walls*	
Cantilevered:	60 pcf loading
Restrained:	60 pcf loading
Seismic Loading:	
	10H for level backfill
	13H for 3:1 backfill
	17H for 2:1 backfill

*Retaining walls should be design with wall back drains and waterproofing to ensure dry condition on the interior.

5.4.2 DESIGN CRITERIA

Code: California Building Code 2022 with amendments in conformance with CSU Seismic Requirements dated Mach 5, 2020

Live Loads:

Stairs and Exit Corridors: ....100 psf

Classrooms: ....40 psf

Laboratories:.......................................80 psf

Roof (areas without equipment):.................20 psf + 5 psf allowance for solar

Mechanical Areas:.................................100 psf or weight of equip. + 50 psf

Deflection Control:

Defections shall be in conformance with CBC 2022 criteria for roofs and floors

½" maximum at exterior walls or based on compatibility with glazing systems

Elevators supports in accordance with elevator manufacturer guidelines

Site Seismic Design Parameters will be in conformance with CSU standards once a soils investigation compliant with CBC 2022 requirements is complete. See Table 1 – CSU Campus Seismic Ground Motion Horizontal Response Spectral Acceleration Parameters for the seismic parameters which vary depending on the site class.

Risk Category: III

Seismic Importance Factor:..............Ie = 1.25

Wind Speed:...............................V_{3S} = 100 mph

Exposure:..................................C

5.4.3 MATERIALS

Concrete Compressive Strength

Mix "A" Foundation Elements:..4,000 psi

Mix "B": For slab-on-ground, normal-weight fill over steel deck

formed slabs and beams, curbs and equipment pads, stair pan fills : ......4,000 psi

Mix "C" & "D": For walls and columns..5,000 psi

Reinforcing Bars.. ASTM A615, grade 60

Welded Reinforcing Bars...ASTM A706, grade 60

Concrete Masonry

CMU Block.................f'm 1500 psi

Grout.......................f'c 2,000 psi

Steel

W-Shapes.....................................ASTM 992, Grade 50

Angles, Channels and Bent Plates ....ASTM A36

Square Round or Rectangular Tube ......ASTM A500, Grade B

Pipe Columns ....ASTM A501 Fy=36 ksi

Plates ....ASTM A572 Fy=50ksi, typical ASTM 36 where noted

High Strength Bolts..........................ASTM 325 Slip Critical

Machine Bolts and Thru Bolts..............ASTM A307

Standard.Anchor Bolts.......................ASTM F1554, Grade 36

High Strength Anchor Bolts ....ASTM F1554, Grade 105

Shear Connector Studs ....AWS d1.1, Type B, Automatic End Weld

Expansion or Wedge Anchors..............Hilti KWIK BOLT TZ expansion anchor or equal

Steel Members at Exterior ....Hot Dipped Galvanized

Metal Deck

Roof Deck...........ASTM A653, Grade 33, Galvanized G50 at interior, G90 at exterior

5.4.4 FRAMING SYSTEMS

Because the building is set into the hillside and will have mix of indoor and outdoor laboratory (outdoor for the Microgrid) the base material for the building at or below grade should be concrete. This will provide a rugged material capable of weathering the marine exposure and provide an exposed outdoor terrace floor slab system that can be easily waterproofed with a system of pavers and water proof membranes. In addition, the retained hillside will require a permanent concrete retaining wall system where the building mass resists the earth pressure. This will require shear walls on the below grade portions of the building situated downhill.

Stories of the building above the grade at the top of the hill can use the lower portion as a podium and therefore use a mix of structural materials including mass timber or steel framing depending on the fire rating requirements and architectural aesthetics.

5.4.5 SUSTAINABILITY

Starting in 2022 projects funded by the State of California will need to comply with the "Buy Clean California Act", see website: https://www.dgs.ca.gov/PD/Resources/Page-Content/Procurement-Division-Resources-List-Folder/Buy-Clean-California-Act

This establishes the maximum acceptable GWP (Global Warming Potential) for new construction:

Eligible material	Maximum acceptable GWP limit (unfabricated)
Hot-rolled structural steel sections	1.01 MT CO_2 eq./MT
Hollow structural sections	1.71 MT CO_2 eq./MT
Steel plate	1.49 MT CO_2 eq./MT
Concrete reinforcing steel	0.89 MT CO_2 eq./MT
Flat glass	1.43 MT CO_2 eq./MT
Light-density mineral wool board insulation	3.33 kg CO_2 eq./1 m^2
Heavy-density mineral wool board insulation	8.16 kg CO_2 eq./1 m^2

Figure 5.4.1 Maximum Acceptable GWP Limit Summary

In addition, concrete has a large embodied footprint because of the carbon emitting process used to make the portland cement. By some estimates production of portland cement is responsible for 5% of the global CO2 emissions. Fly ash may be substituted for portland cement to reduce the embodied carbon of the concrete.

The following recommendations apply to concrete mix designs available in the area and consider the quality of locally available aggregate. 15% fly ash substitution may be made without impacting strength for concrete with up to f'c = 5 ksi. At this level of substitution, it improves the workability of the concrete and is less expensive than the Portland cement it replaces. Up to 25% substitution for f'c less than or equal to 5 ksi may be used although concrete quality begins to degrade because it is harder to work and strength is impacted. 35% may be used in foundations or retaining walls where there is little need to work the concrete but strength is limited to f'c = 4 ksi and is determined based on 56 days rather than the traditional 28 days.

Cast-in-place concrete should utilize cementitious and aggregate materials produced locally as much as possible.

5.5 MECHANICAL

The following narrative describes the mechanical (HVAC) systems to be provided for the new Energy Resource & Sustainability Center at Cal Poly Humboldt. The project will be provided with mechanical systems that are cost-effective, energy-efficient, environmentally friendly, easily maintainable, and appropriate for the coastal location's corrosive moist air. Strategies will be employed to conserve energy in conjunction with various sustainability and wellness strategies. Design of the mechanical system shall promote forward thinking in engineering and be flexible in design incorporating minimum requirements needed to ensure a safe and healthy building while applying guidelines to minimize the environmental impact.

All mechanical systems shall be designed to promote reliability, serviceability, flexibility, and capacity for future renovation. Mechanical systems and equipment shall be all-electric, with an emphasis on heat pumps for supplying comfort heating and cooling (if required), and be sized to accommodate worst-case operational conditions. The system shall be designed to accommodate and promote the four "S's" of grid-integration: Shape, Shift, Shed, Shimmy. In addition, wherever possible, natural refrigerants, or refrigerants with global warming potentials of 500 or less should be used.

5.5.1 DESIGN CONDITIONS

Cal Poly Humboldt campus is located in Arcata, CA, which has the following CA T24 Part 6 design conditions:

Climate Zone:	1
Latitude:	41.0°N
Longitude:	124.1°W
Elevation:	203 ft
Cooling 0.1% Drybulb:	75°F
Cooling 0.1% MCWB:	61°F
Heating 0.2% Drybulb:	31°F
Heating Degree Days:	5029 HDD

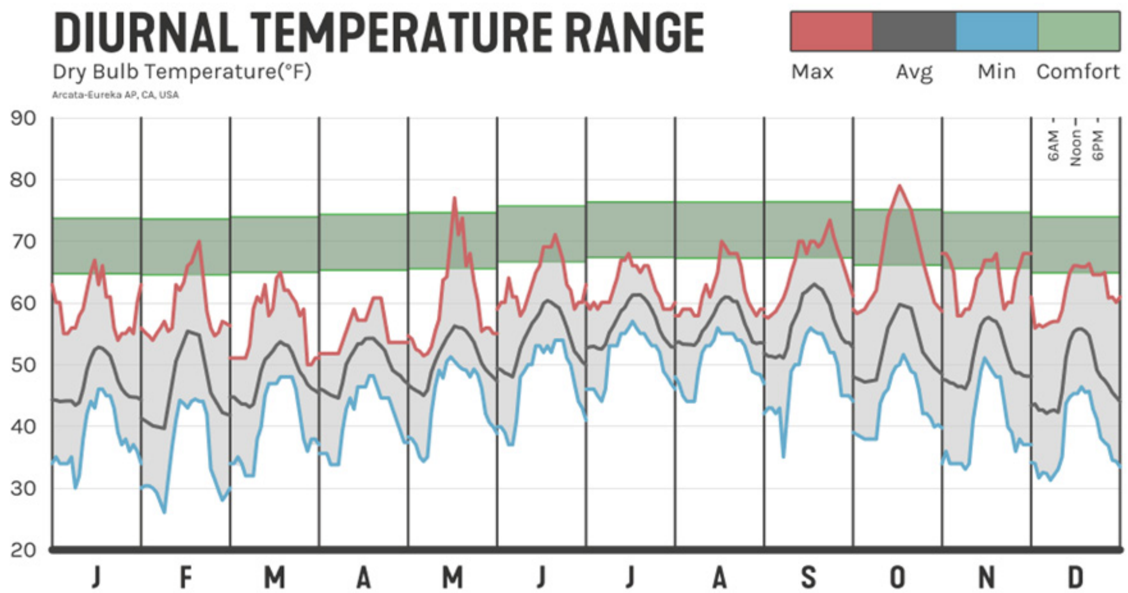


Figure 5.5.1 Historical Diurnal Temperature Range, Arcata, CA

With Climate Change, projected temperatures in Arcata are anticipated to increase. The HVAC design should reflect the anticipated increases in temperatures and the potential impact this will have on design loads for both heating and cooling. Where cooling may not have been historically needed in this climate zone, increasing peak day conditions may necessitate the inclusion of active cooling.

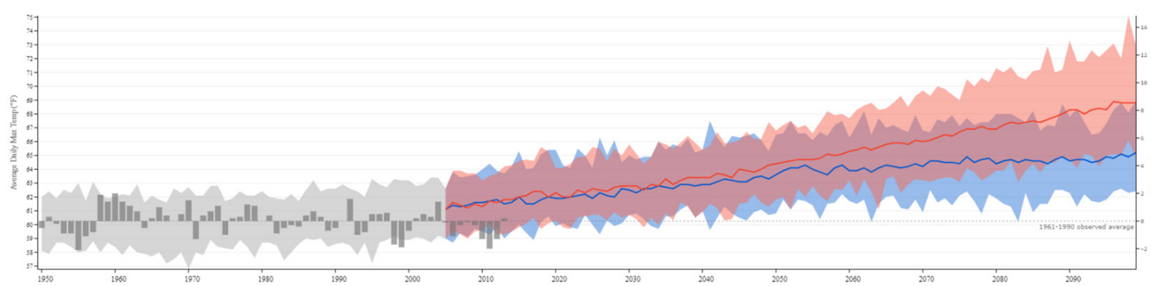


Figure 5.5.2 Anticipated Future Temperature Ranges

Under a high and low Global Emissions Model for Arcata, CA

5.5.2 HEATING AND COOLING SYSTEMS

Given the computational intensity of the program at the Energy Resource & Sustainability Center, as well as the anticipated internal loads resulting from the electrical equipment in the test labs, it is likely that there is considerable amounts of heat recovery available in the program to offset a portion of the heating loads. In a traditional high-intensity program type for this climate zone, an economizer would provide a substantial amount of cooling.

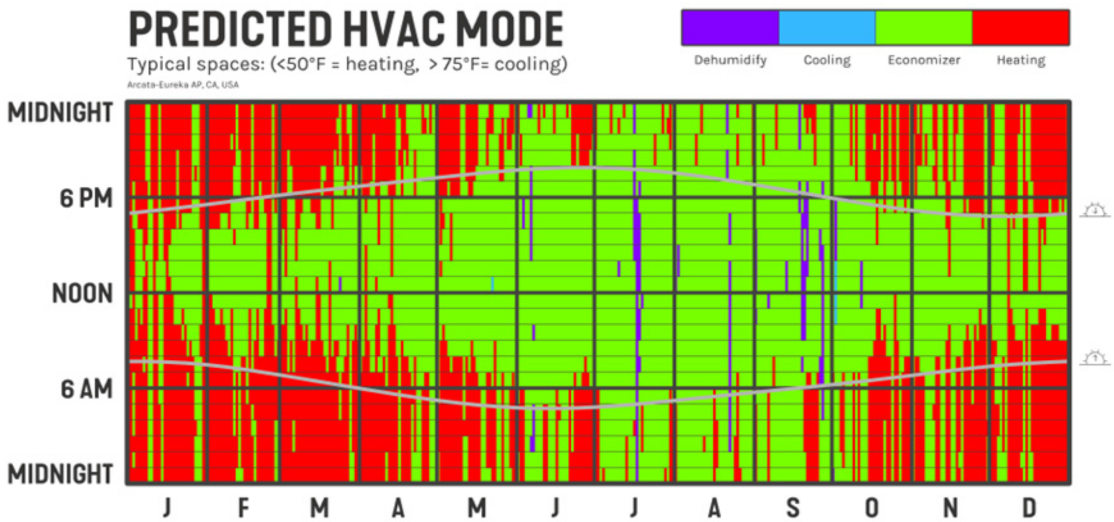


Figure 5.5.3 Anticipated HVAC Mode for an all-air System

However, given the high annual heating demand in this climate zone and available waste heat from internal loads, the design team should evaluate the following systems for suitability in additional to traditional systems:

Mechanical System

- Variable Refrigerant Flow (VRF System) with DOAS Ventilation
  - Heat Recovery VRF Outdoor Unit
  - Flat plate Heat Recovery on DOAS unit

Alternate Mechanical Systems

- 4-Pipe Heat Recovery Air-Source Heat Pumps and hydronic distribution
  - Local hydronic fan coils located for each thermal zone, plus DOAS Ventilation with heat recovery.
- Thermal Energy Storage
  - Load Shifting / Grid Alignment
  - Optimizing Heat Recovery
  - Optimizing Heating Alignment with favorable Outside Air Temperatures (OAT)

Temperature Regimes

To enable exceptional efficiency, and to assist with meeting a net zero energy goal, the supply water temperature for a heat pump-based heating system is critical. The following chart indicates the relationship between Coefficient of Performance, Outside Air Temperature, and the supply water temperature of an air-source heat pump. Given Arcata's cool climate and predominantly heating conditions, the selected supply water temperature is critical for energy performance.

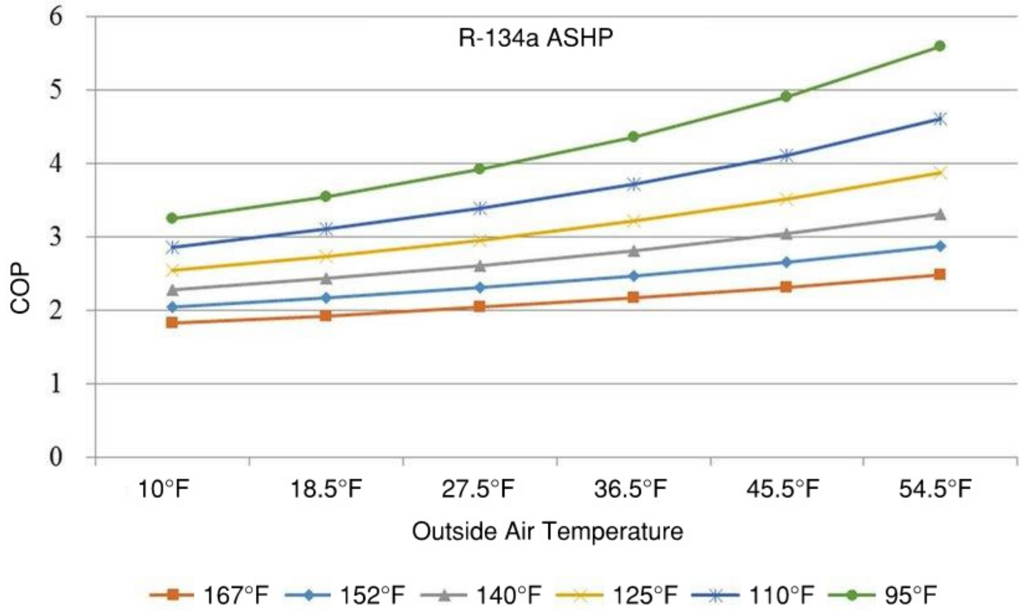


Figure 5.5.4 Supply Water Temperature

For efficient performance in Climate Zone 1, the design team should design any heating hydronic systems around the following criteria:

- Heating Hot Water Systems — 95°F - 110°F
- Medium Chilled Water Systems — 55°F - 60°F
- Dehumidification — Where required, consider the use of a dedicated low temp chilled water loop or DX system.

Special consideration should be given to Wetbulb temperatures during the heating season in this coastal climate zone. Air-source Heat Pumps (ASHP's) in heating dominated coastal zones can experience excessive frost build up on the evaporator coil. This buildup of frost will trigger significant hours of defrost cycle for the heat pump. The defrost cycle in most ASHP's significantly reduces the heating capacity if not eliminating it all together. Pairing the ASHP with thermal energy storage, including an acceptable system volume, and/or adding supplemental ASHP units is crucial to meeting the system heating demand.

Heat Pump Selection and Refrigerants

Although an R-134 COP graph is shown above, the design teams shall evaluate an appropriate 4-pipe ASHP which utilizes low-GWP refrigerants, including the potential use of natural refrigerants. The design team shall include refrigerant leakage and end of life emissions into their analysis and present it to Cal Poly Humbolt for decision making.

Thermal Energy Storage

It is highly recommended that the project include thermal energy storage (TES). TES can provide significant load shifting capacity to the HVAC system. In addition, the strategic use of TES can provide demand charge savings as well as resilience. TES can play a critical role in a fully integrated Micro-grid, providing both load shaping and shifting capacity.

Preliminary TES Sizing – The team should consider initial hot water storage tank sizing at 10,000 gallon size. Assuming a 15F degree delta T on the storage size, a 10,000 gallon tank would provide an estimated 94 ton-hours of storage capacity, resulting in approximately 5 hours of estimated load shifting capacity.

5.5.3 VENTILATION

Ventilation is critical to the health and wellbeing of students, staff and faculty. Research laboratories require special attention to providing appropriate levels of ventilation. Ventilation rates will be the higher of CA Title 24 and 30% above ASHRAE 62.1 requirements for each space type, whichever is greater. In response to the COVID pandemic, and in alignment with ASHRAE Epidemic Taskforce, the project will limit the potential for exhaust air re-entrainment. The design team should review design solutions that include Dedicated Outdoor Air Systems (DOAS). Such systems do not recirculate ventilation air within the building.

Heat/Energy Recovery

It is advised to include air-to-air heat recovery devices if a DOAS system is used. Given the heating dominated climate zone and potentially high air-change rates associated with the lab spaces, heat recovery ventilation will reduce peak heating loads on the central heating heat pumps as well as reduce energy use. Reducing peak loads will reduce the heat pump sizes and potentially reduce cost.

Exhaust Systems

Where the room program and/or equipment within the space requires dedicated exhaust, exhaust shall be provided in accordance with the California Mechanical Code. Given the potential for electrical work to be performed in the lab spaces, localized snorkel exhausts are recommended at work benches that may be used for soldering.

5.5.4 MAINTENANCE AND SERVICEABILITY

The California coast is extremely corrosive to mechanical equipment. All equipment that is able to be installed indoors should be located within conditioned space. For equipment that must be located outdoors, such as ASHP's, exhaust fans, and exterior louvers, all equipment should be specified with the highest level of corrosion resistance the project can afford. In addition, the design team should consider putting equipment below protective roofs and/or screens where appropriate to reduce environmental exposure wherever possible.

5.6 PLUMBING

The following narrative describes the plumbing systems to be provided for the new Energy Resource & Sustainability Center at Cal Poly Humboldt. The project will be provided with plumbing systems that are cost-effective, energy-efficient, environmentally friendly, and easily maintainable. Strategies will be employed to conserve energy in conjunction with various sustainability and wellness strategies. Design of the plumbing system shall promote forward thinking in engineering and be flexible in design incorporating minimum requirements needed to ensure a safe and healthy building while applying guidelines to minimize the environmental impact.

All plumbing systems shall be designed to promote reliability, serviceability, flexibility, and capacity for future renovation. Plumbing systems and equipment shall be all-electric, with heat pumps being the preferred recommendation, and be sized to accommodate worst-case operational conditions. The design of the systems and materials shall not compromise the systems' required cleanliness or purity levels.

5.6.1 DOMESTIC WATER

Metered domestic water service with backflow preventer will serve the building. Minimum of 35 psi shall be delivered at the most hydraulically remote fixture.

Non-potable industrial water systems will be provided for laboratory fixtures and make-up water for equipment, as required. The non-potable water systems will be separated from the domestic water systems through reduced pressure backflow preventers.

Emergency showers and eyewashes, where required, will be supplied with tepid water per the ANSI Z358.1 definition of tepid water.

5.6.2 DOMESTIC HOT WATER

Option 1: Point-of-Use Electric Water Heaters

Provide localized tankless water heaters below each fixture requiring hot water.

Option 2: Central Domestic Hot Water Heat Pumps

Provide a central, recirculating hot water system served by electric heat pump units, complete with refrigerant-to-water heat exchangers, as needed, storage, and swing tanks. Heat pump units may be of the air-source type, or pending the mechanical HVAC system, water-source type with the ability to simultaneously generate chilled water.

If there are lab fixtures requiring hot water, a separate heat pump system will be provided to produce domestic industrial hot water.

Any equipment located outdoors shall be provided with protective coatings for corrosive environments.

The domestic hot water system will also support mixing valves, if required, at emergency safety showers and eyewashes.

Kitchenette dishwashers shall have internal heaters for water heating and only require a domestic cold-water connection.

5.6.3 NATURAL GAS

The design team has identified the sustainability goals of reducing greenhouse gas emissions and eliminating natural gas from the project wherever possible however, a natural gas service will be provided to the site to serve the back-up generator only.

5.6.4 SANITARY WASTE & VENT

The building will be provided with a sanitary waste & vent system. At this time, it is assumed a sewage ejector is not needed and all sanitary waste will discharge from the building by gravity.

5.6.5 STORM DRAIN

A storm drainage system will be provided to convey rainwater from the roof of the building and any balconies / plazas to point of discharge outside the building. An overflow drain system will be daylit to the exterior of the building.

Roof area will be drained to bioretention areas/planters as well as to a rainwater harvesting cistern which is to be located on site outside of the building footprint (design by Civil).

Reclaimed water (purple pipe) piping will be provided from 5' outside of the building into the building for connection to flush water closets and urinals.

5.6.6 PLUMBING FIXTURES

All applicable fixtures will meet the American Disabilities Act (ADA) for accessibility. The design team will use advanced innovative, water-efficient plumbing fixtures to help attain water conservation goals. Plumbing Fixtures shall be highly efficient, decreasing total water demands without negatively impacting the quality of life.

Emergency Fixtures

Emergency fixtures will be provided in rooms where corrosive or hazardous materials are handled or as required by the building program.

TYPE OF FIXTURE	NUMBER OF FIXTURES		WATER FIXTURE UNIT VALUE	
WATER CLOSET (FV)	8	X	10	=
URINAL (FV)	2	X	5	=
LAVATORY	8	X	1	=
DRINKING FOUNTAIN/ BOTTLE FILLER	2	X	0.5	=
SINK	14	X	1.5	=
MOP SINK / SERVICE SINK	2	X	3	=
SHOWER	0	X	2	=
THREE-COMPARTMENT SINK	0	X	3	=
HOSE BIBB	1	X	2.5	=
HOSE BIBB (EACH ADDITIONAL)	5	X	1	=
SUB-TOTAL DOMESTIC WATER FIXTURE UNITS:				
WSFU CONVERTED TO FLOW (GPM):				
LAB SINK	0	X	2	=
SUB-TOTAL INDUSTRIAL WATER FIXTURE UNITS:				
WSFU CONVERTED TO FLOW (GPM):				
CART WASHER (GPM)	0	X	20	=
RO/DI MAKEUP (GPM)	0	X	5	=
MECHANICAL MAKEUP (GPM)	1	X	10	=
BUILDING SUB-TOTAL WATER SUPPLY (GPM):				
BUILDING SUB-TOTAL WATER SUPPLY + 20% FUTURE CAPACITY (GPM):				
EMERGENCY SHOWER/ EYEWASH (GPM)	4	X	23	=
BUILDING SUB-TOTAL + ADDITIONAL CAPACITY + ESEW:				

Figure 5.6.1 Water Supply Fixture Unit Calculations

5.7 ELECTRICAL

The following section provides a summary of the relevant Electrical criteria and recommendations for the "Energy research + Sustainability Center" ER+SC Building which will be an academic and research building. The building shall be single story but half of the building is elevated.

The objectives of the Electrical Design are to establish uniformity of design, best overall cost-effective installation, and construct an Electrical system that is robust and consistent with exceptional research and educational building. The design of the Electrical systems shall meet the program requirements with commitment to sustainability and energy-efficiency.

Power and distribution systems are intended to have ample capacity to meet future demand. The systems shall include provisions for future loads as determined by the project. This building shall be All-Electric not relying on natural gas for water and space heating. There will be a natural gas supply for the Simulation Lab Natural Gas Generator.

This building programming consists of the following facilities:

- Exterior Solar Laboratory
- Grid Simulation Laboratory
- Grid Simulation Data Center
- Outdoor Ground Level Laboratory
- Training Laboratory / Classroom

5.7.1 CODE AND STANDARDS

The Electrical design shall comply with the latest edition of the applicable codes and standards as listed below. In addition, the system shall comply with other relevant safety guidelines as required by the program.

Applicable Codes:

- California Administrative Code Part 1, Title 24, California Code of Regulations (CCR)
- California State Fire Marshal Regulations
- City of Arcata Municipal Codes
- California Building Code (CBC) – Part 2, Title 24, CCR
- California Electrical Code (CEC) – Part 3, Title 24, CCR
- California Mechanical Code (CMC) – Part 4, Title 24, CCR
- California Plumbing Code (CPC) – Part 5, Title 24, CCR
- California Energy Code (CEC) – Part 6, Title 24, CCR
- California Fire Code (CFC) – Part 9, Title 24, CCR
- California Green Building Standards Code – Part 11, Title 24, CCR

- NFPA 101 – Life Safety Code
- NFPA 70E – Standard for Electrical Safety in the Workplace

Applicable Standards

- IEEE – Institute of Electrical and Electronic Engineers
- IESNA – Illuminating Engineering Society of North America Handbook
- ICEA – Insulated Cable Engineers Association
- NEMA – National Electrical Manufacturers Association
- NFPA – National Fire Protection Association
- UL – Underwriters Laboratories
- ADA – American with Disabilities Act
- ASTM – American Society of Testing and Materials
- OSHA – Occupational Safety and Health Administration
- ANSI – American National Standards Institute
-

Applicable Guidelines

- CSU Campus Design Guidelines

5.7.2 ELECTRICAL SERVICE

A load analysis was completed for the building. It was based on a volt- amperes (VA) per square foot calculation utilizing the gross square footage (GSF) of building areas, and estimated VA load of large equipment such as HVAC.

Space Description	Proposed Area (SF)	HVAC (VA/SF)	Plumbing (VA/SF)	Recept/Eqpt (VA/SF)	Lighting (VA/SF)	Total VA/SF per space
Common Spaces	1,275	5	3	2.5	1.3	11.8
Meeting , Office and Workspace	4,800	10	.5	5	3	18.5
MicroGrid Research Lab	7,260	15	1	60	3	79
Classroom	1,650	10	.5	2.5	3	16

There will be (2) electrical services and below describes which loads are supported:

1. Building Electrical Service

   a. Building HVAC and Plumbing loads

   b. Lighting and lighting controls for the building and site/exterior.

c. Convenience outlets, office and classroom general receptacles and appliances

d. Data Center including the servers, estimated at 10kVA load on each rack.

e. Elevator

f. Microgrid Simulation Lab equipment

g. Outdoor Lab equipment

h. PV Inverter 50kVA

2. Simulation Electrical Service

a. Overhead 12kV Test Grid

b. (3) Test PV Inverters

c. Test EV Fast Charger

d. Test BESS Type 1 Tesla PP2

e. Test BESS Type 2 Model TBD

f. MV Fault Simulator

g. (3) Grid Simulators and Programmable Inductors

h. 50kW of Building HVAC and Water Heating Heat pumps

5.7.2.1 BUILDING ELECTRICAL SERVICE CALCULATION

Overall Building Load (KVA) = 401KVA

+25% Spare Capacity (KVA) = 501KVA

Service Load (Amps at 480V) = 482A

+25% Spare Capacity (Amps) = 603A

Recommended Service:

Service MV Transformer = 500KVA

Building Service Main Switchboard Rating = 800A Main Breaker, 1,200A bus

Service switchboard is sized with larger capacity to allow the transformer to be overloaded for a short time.

5.7.2.2 SIMULATION ELECTRICAL SERVICE CALCULATION

Simulation Test Loads:

(2) 300kVA Test Yard Transformers with non-coincidental loads as follows:

- (3) PV Inverters (108kVA each) = 324kVA
- (3) Grid Simulator and Programmable Inductors (112.5KVA each) = 337kVA
- EV Fast Charger = 200kVA

Overall Simulation Test Loads (KVA) = 600KVA (MAX)

Service Load (Amps at 480V) = 722A

+25% Spare Capacity (Amps) = 903A

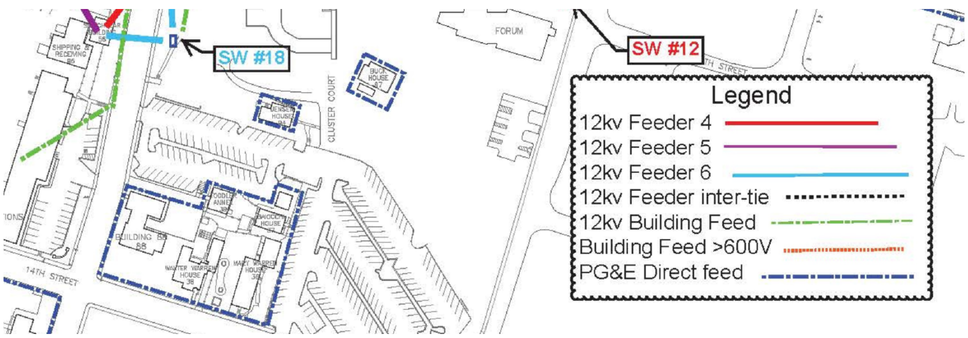
Recommended Service:

Service MV Transformer = 750KVA

Simulation Service Main Switchboard Rating = 1,200A Main Breaker, 1,200A bus

5.7.3 SITE ELECTRICAL UTILITIES

The normal power to the building will be served from an existing Central Utility Plant with 12.47kV service. Capacity of the Central Utility Plant should be evaluated in detail and confirm that the campus MV service has capacity. It is noted that it currently have sufficient capacity for the addition of this building. It is recommended to tie from MV Feeder #6, Grid Switch #18, as it is the closest to the site. New underground conduit duct bank with (2) sets of 5" conduits (one spare) with another (2) sets of 5" conduits for future campus loads.



Service feeders shall terminate to a 4-point junction outdoor gear. This feeds the 500kVA Building MV transformer and 750kVA Simulation MV Transformer. Building and Simulation MV transformer shall be 12.47kV-480/277V pad mounted, natural esther oil-filled type. Spill containment shall be not be required.

5.7.4 EMERGENCY POWER

The emergency power needs for the building are to serve the emergency egress lighting to meet the code. A central emergency lighting inverter UL 924 shall provide minimum 90-minute battery backup.

Fire Alarm Control Panels shall be provided with built-in batteries for emergency power back up.

The ER+SC Building Electrical Service have critical research equipment including data center servers. The building service shall be backed up by standby power in case of power outage occur to preserve data and allow continuity of the research operations. The building load shall be fully backed by 490kW BESS with 2-hour runtime and the battery will provide a seamless power transfer without dropping the critical IT loads.

The Grid Simulation Outdoor Yard shall allow connecting a 600KVA Trailer Mounted Natural Gas Generator for testing purposes, not for back up.

5.7.5 POWER DISTRIBUTION

The power distribution for the electrical service to the building and the Grid Simulation Equipment are graphically described in the Appendix Items 7.3 Energy Research Space Plans / Single Line Diagram and 7.4 Energy Research Supplemental Items.

5.7.5.1 BUILDING DISTRIBUTION

- 1,200A bus, 480/277V, 3-phase, 4-wire main switchboard with 800A main breaker
    - The main switchboard shall serve the HVAC equipment
    - Connects building 50kVA PV inverter
    - Includes 800A breaker for the 490kW BESS backup power
- 100A Lighting Panel
- 112.5kVA transformer and (1) 400A Power/Receptacle Panel for Grid Simulator Lab
- 112.5kVA transformer and (2) 200A Power/Receptacle Panels for Classrooms
- 75kVA transformer and (1) 200A Power/Receptacle Panel for Outdoor Yard
- 30kVA transformer and (1) 100A Power/Receptacle Panel for Outdoor Solar Lab
- 75kVA transformer and (1) 200A Power/Receptacle Panel for general building use, plumbing loads

5.7.5.2 SIMULATION DISTRIBUTION

- 1,200A bus, 480/277V, 3-phase, 4-wire main switchboard with 1,200A main breaker
- 800A Manual Transfer Switch for normal power and standby power from 600kVA Natural Gas Generator
- 750kVA Generator Step-up Transformer 480Y/277V to 12kV
- Overhead 12kV Test Grid including utility poles, 12kV switches, surge arresters, reclosers
- 1,200A bus, 12kV, 95 BIL, 3-phase, 3-wire MV switchgear
- 2500kVA Fault Simulation MV Transformer
- 12kV Grounding Transformer
- 300kVA TestYard Transformer #1, 12kV to 480Y/277V, 3-phase, 4-wire
- 600A, 480Y/277V, 3-phase, 4-wire Outdoor SwitchYard Switchboard #1
- 300kVA TestYard Transformer #2, 12kV to 480Y/277V, 3-phase, 4-wire

- 600A, 480Y/277V, 3-phase, 4-wire Outdoor SwitchYard Switchboard #2
-

5.7.5.3 SWITCHYARD #1 AND #2 DISTRIBUTION

- Low Voltage Fault Simulation Dry-type Transformer #1 and #2
- Test EV Fast Charger
- (1) 480-208Y/120V, 3-phase, 4-wire Transformer
- (1) 208Y/120V, 3-phase, 4-wire Panelboard
- Test BESS Type 1 Tesla PowerPack 2.5 rated at 140kW 2 hour
- Test BESS Type 2 Model TBD, Grid forming DER rated at 150kW
- 50kW of building HVAC and Water Heating Heat pumps
- Supports the Grid Simulation Lab Distribution, see below.

5.7.5.4 GRID SIMULATION LAB DISTRIBUTION

- Portable 150kVA Transformer
- (3) Grid Simulators and Programmable Inductors
- (3) Test Rack mounted PV Inverters

The grounding system for the building shall be provided complete with main service grounding utilizing ground rods, Ufer or concrete encased electrode, and cold-water pipe. Provide ground busbar in electrical rooms, including the labs, data center, test yard and storage room of electrical equipment.

5.7.6 METERING AND POWER QUALITY

On-board digital metering system shall be provided within all switchboard, distribution boards and data center panelboards. The metering system shall report power quality issues to the BMS or other power monitoring system.

To protect sensitive electronic and data center equipment, Surge Protective Device (SPD) level 1 and 2 shall be provided at all switchboards and distribution boards serving laboratory, data center and sensitive equipment.

Variable Frequency Drive (VFD) Controllers for HVAC and plumbing equipment generates nuisance harmonics. Active harmonic filtering system shall be provided if built-in filters at each VFD cannot be provided.

5.7.7 GENERAL MATERIALS

Distribution panels and power panels will be circuit breaker-type. Molded-case and insulated-case breakers will be used. Lighting panels will be commercial-type with bolt-on circuit breakers. Bussing will be copper. Panelboards will be provided with a "door-in-door" construction to allow for entire front cover to swing open for easy maintenance.

Transformers will be provided to convert 480 volt power to 208Y/120 volt for receptacle and equipment needs. Transformers shall be NEMA 1 or 4X as required. Transformers shall be standard high efficiency, NEMA STP TP1 dry-type rated for 115o C rise. Windings will be copper. Transformers shall be floor mounted within electrical rooms, as much as possible. Transformers serving sensitive loads shall be equipped with Electrostatic Shielding, and shall be K-rated according to the application.

All floor mounted large distribution equipment shall be provided with concrete pad.

Disconnect switches will be heavy-duty fuse type.

All distribution equipment shall be consistent of the same manufacturer.

All outdoor electrical equipment shall be with enclosure rated for marine environment equal to NEMA 4X rated stainless steel for corrosion resistance.

Raceways

- Rigid steel conduit – feeders, branch circuits, exposed.
- PVC – feeders and branch circuit underground.
- EMT – feeder, branch circuits, and low voltage.
- Flexible Metallic Conduit (FMC): May be used in dry locations for connections from adjacent outlet boxes to motors, transformers, vibrating equipment and machinery and lighting fixtures installed in suspended ceilings, minimum sizes shall be 3/8" for lighting fixtures and control wiring and ½" for motor and transformer connections.
- Liquid tight Flexible Metallic Conduit (LFMC): May be used in damp and wet locations for the same applications as for Flexible Metallic conduit specified under this Section. Connections to all pump motors, solenoid valves, float switches, flow switches and similar devices shall be made using liquid tight flexible metallic conduit. Minimum sizes shall be 3/8" for lighting fixtures and control wiring and ½" for motor and transformer connections.

Conductors

- Provide insulated copper conductors for all wires and cables. Use stranded conductors for AWG #8 and larger sizes. Medium voltage wires and cables shall be aluminum.
- Provide minimum AWG #12 Cu for all power and lighting branch circuits. Provide minimum AWG #14 Cu for all signal and control circuits.
- Feeders and branch circuit wiring shall contain a separate green insulated grounding conductor
- Use NEC type THW, THWN or Type XHHW for feeders and branch circuits in wet or dry locations. Use NEC type THHN for branch circuits in dry locations.
- Use NEC type XHHW, rated 90 degrees C in dry locations and 75 degrees C in wet locations, for exterior branch circuit wiring and for circuits served by ground fault interrupting circuit breakers.

Boxes

- Four inch square by 1-1/2" minimum sheet metal boxes for interior use.

- Two inch wide by three-inch long steel switch boxes, ganged together for multiple switches.

Devices

- Receptacles – 20 amp, 125 volt, duplex, grounding type, specification grade, convenience outlets. Receptacles shall be white or as specified by electrical identification or architect. Provide 20 amp GFCI receptacles in locations where required by code. Controlled receptacles shall be green in color and labeled as controlled by an industry standard method.
- Switches – low-voltage momentary contact compatible with lighting control system. Switches shall be white.
- Cover plates shall be stainless steel in Lab areas and thermoplastic white elsewhere.

5.7.8 LIGHTING CONTROLS

The lighting control system will be designed to comply with the requirements of Title 24.

Multilevel lighting controls shall be provided as required with the appropriate dimming scheme and local override controls. Areas with dimming control will include all spaces with a lighting power density greater than 0.5 W/ft^2 and larger than 100 ft^2.

The automatic shut-off controls for the building will be a combination of a lighting control system for common areas and localized occupancy sensors in restrooms, utility rooms, and other small spaces.

Dual-technology (passive infrared/ultrasonic) occupancy sensors will be used for control of storage spaces, bathrooms, janitorial rooms, private offices, conference rooms and other areas subject to intermittent occupancy. Occupancy sensors will be provided with auxiliary inputs and will integrate with the BMS system to control VAVs where specified by the mechanical engineer.

Daylight sensors will be used to lower lighting levels when natural lighting is sufficient. Areas requiring automatic daylight control include primary and secondary sidelit zones. Reduction in lighting output will be provided by continuous dimming.

5.7.9 ON-SITE RENEWABLE ENERGY & BATTERIES

Starting effective in January 2023, Title 24 Section 140.10 code will require all newly constructed building with types such as High-rise Multi-Family, Offices, Schools, Auditoriums, and Libraries. It is anticipated that the Energy Research + Sustainability Center ER+SC Building will have to comply with the code under the category of "School". The building is already with PV and battery storage, and validation of final PV and Battery Storage sizing should be evaluated if it meets the code.

The photovoltaic (PV) system shall be sized not less than the smaller of the PV system size determined by the code Equation 140.10-A or the total of all available Solar Access Roof Areas (SARA) multiplied by 14W/sqft.

The PV system shall also have a battery storage system meeting the minimum requirements. The rated energy capacity and the rated power capacity shall be not less than the values determined by the code Equation 140.10-B and Equation 140.10-C, respectively.

TABLE 140.10-A - PV CAPACITY FACTORS

	FACTOR A—MINIMUM PV CAPACITY (W/ft2 of conditioned floor area)		
CLIMATE ZONE	1, 3, 5, 16	2, 4, 6—14	15
Grocery	2.62	2.91	3.53
High-Rise Multifamily	1.82	2.21	2.77
Office, Financial Institutions, Unleased Tenant Space	2.59	3.13	3.80
Retail	2.62	2.91	3.53
School	1.27	1.63	2.46
Warehouse	0.39	0.44	0.58
Auditorium, Convention Center, Hotel/Motel, Library, Medical Office Building/Clinic, Restaurant, Theater	0.39	0.44	0.58

TABLE 140.10-B - BATTERY STORAGE CAPACITY FACTORS

	FACTOR B — ENERGY CAPACITY	FACTOR C — POWER CAPACITY
Storage-to-PV Ratio	Wh/W	W/W
Grocery	1.03	0.26
High-Rise Multifamily	1.03	0.26
Office, Financial Institutions, Unleased Tenant Space	1.68	0.42
Retail	1.03	0.26
School	1.87	0.46
Warehouse	0.93	0.23
Auditorium, Convention Center, Hotel/Motel, Library, Medical Office Building/Clinic, Restaurant, Theater	0.93	0.23

5.8 AV / IT / TELECOM

Energy Research + Sustainability Center – Feasibility Study

- The following provides a description of telecom systems for Cal Poly Humboldt - Energy Research + Sustainability Center in a narrative form.
- Telecom systems are based on TIP standards, and are presented for an assessment by the Owner to provide additional review and note any exceptions specific to the Cal Poly Humboldt campus that may vary from TIP.

5.8.1 OVERVIEW

The scope of work for the telecommunications system consists of the following components:

- Telecommunications Spaces
- Pathways
- Backbone Cabling
- Horizontal Cabling
- Firestopping
- Grounding and Bonding
- Testing and Labeling

5.8.2 EQUIPMENT SPACES

5.8.2.1 Equipment Spaces – MDF/MPOE

The building will have a minimum point of entry (MPOE) for telecommunications utilities combined with the building's main distribution facility (MDF).

The MPOE will house demarcation equipment (copper and fiber optic facilities) originating from the campus OSP network.

Telephone and Internet services are already provided elsewhere on campus and will route to this building over Cal Poly Humboldt's network.

The MDF/MPOE will be located on a floor that resides in the center of the building (depending on the final quantity of building stories) and will house the following equipment:

- Base Building Network Equipment
- Backbone Cabling Terminations

- Horizontal Cabling Terminations
- Mechanical Cooling Equipment
- Electrical UPS

Architectural Requirements:

- The MDF is approximately 180 sq. ft. (12'x15')
- Floor: durable, anti-static floor covering
- Ceiling: open to the deck above
- Walls: Two-hour rated full height walls with 3/4" fire retardant plywood. Paint plywood with a low-gloss white paint masked around the fire-retardant labels on plywood.
- Door: 7' 0" high by 3' 0" wide, no sill

Electrical Requirements:

- Support a load of 3kW per rack or cabinet
- Each cabinet will receive two dedicated NEMA L5-20R receptacles. Mount receptacles on cable tray above each cabinet.
- Provide one duplex convenience receptacle per wall, mounted at 18" AFF.
- For each network equipment rack, provide a vertical rack mount smart PDU.
- Include a dedicated 100A panelboard.

Mechanical Requirements:

- Support a connected load of 3 kW per rack or cabinet.
- Provide continuous 24/7/365 cooling with local control.
- Maintain a temperature range between 65F and 80F.

Lighting Requirements:

- Provide a minimum light level of 50 foot-candles at 3' 0" AFF.
- Install lights on either side of racks – lights should not be located directly above the racks
- Provide cages on light fixtures (recommended).
- Provide a light switch near the door.

Fire Protection Requirements:

- Provide a pre-action, dry pipe system.
- Equip sprinkler heads with protective cages.

Security Requirements:

- Electronic key access (card reader)

Bonding Requirements:

- A Telecommunications Primary Bonding Busbar (PBB) is provided within the main electrical room.

- A Secondary Bonding Busbar (SBB) will be installed within the MDF. Provide a 1/0 AWG conductor from the TMGB to the TGB in the MDF. Use an irreversible connection method to connect the conductor, preferably an exothermic weld.
- Provide bonding conductors from the TGB to the following components within the MDF:

1. Equipment Racks
2. Equipment Cabinets
3. Termination Equipment
4. Cable Runway
5. Cable Tray
6. Building Steel (if available)
7. Electrical Panel
8. Security Panel
9. Conduits and sleeves entering the room
10. Armored Fiber Optic Cables

Telecommunications Equipment Requirements:

- Minimum of four, four-post racks will be required for the MDF/MPOE.

5.8.2.1 EQUIPMENT SPACES - TELECOMMUNICATION ROOMS (TRs)(IDFs)

IDFs connect back to the MDF in star-topology with home runs of fiber and copper.

The IDFs will house the following equipment:

- Base Building Network Equipment
- Backbone Cabling Terminations
- Horizontal Cabling Terminations
- Security System Equipment
- Mechanical Cooling Equipment
- Electrical UPS

Architectural Requirements:

- Each IDF is approximately 120 sq. ft (10’x12’) and will be centrally located (to minimize cabling distances) and stacked.
- Vertically stacked through the building.
- Floor: durable anti-static floor covering
- Ceiling: open to deck above

- Walls: Two-hour rated full height walls with ¾" fire retardant plywood. Paint plywood with a low-gloss white paint masked around the fire-retardant labels on plywood.
- Door: 7' 0" by 3' 0" wide, no sill

Electrical Requirements:

- Support a connected load of 2.5 kW per rack
- Each rack will receive two dedicated NEMA L5-20R receptacles. Mount receptacles on cable tray above each cabinet.
- Install a rack-mounted UPS unit. Size the UPS systems to support the full connected equipment load for a minimum of 15 minutes.
- Provide one duplex convenience receptacle per wall, mounted at 18" AFF.
- Provide a vertical rack mount smart PDU.

Mechanical Requirements:

- Support a connected load of 2.5 kW per rack or cabinet.
- Provide continuous 24/7/365 cooling with local control.
- Maintain a temperature range between 65F and 80F.

Lighting Requirements:

- Provide a minimum light level of 50 foot-candles at 3' 0" AFF.
- Install lights on either side of rack – lights should not be located directly above the rack
- Provide cages on light fixtures (recommended).
- Provide a light switch near the door.

Security requirements:

- Electronic key access (card reader)

Fire Protection Requirements:

- Provide sprinklers with high temperature heads and protective cages

Bonding Requirements:

- Provide a 1/0 AWG conductor from TMGB to the TGB in each IDF room.
- Provide bonding conductor from the TGB to the following components within the IDF:
    1. Equipment Racks
    2. Cable Runway
    3. Cable Tray
    4. Building Steel (if available)
    5. Electrical Panel
    6. Security Systems Panel

7. Conduits and Sleeves Entering the Room
8. Armored Fiber Optic Cables

Telecommunications Equipment Requirements

- Minimum of two, 2-post racks will be required for each IDF.

5.8.3 BASE BUILDING PATHWAYS

5.8.3.1 CABLE TRAY (PRIMARY PATHWAYS)

Size cable tray based on quantity of telecom cabling per initial installation with 30% spare capacity for future growth. Standard tray is a 4" high (4" loading depth) wire mesh style cable tray. Width varies based on cable quantities. Cable tray will run in areas with accessible ceilings. Powder-coat (factory-painted) visible cable tray to match ceiling space color or as directed by the Architect.

Provide seismic bracing to conduit systems as approved by the structural engineer.

Provide fire rated assemblies where cable tray passes through fire rated walls. Determine quantities of sleeves based on quantity of telecom cabling per initial installation with 30% spare capacity for future growth.

Provide supports at each connection point (junction of 2 or more straight sections), direct transitions, at the end of each run and at other locations necessary to attain a fully supported and seismically braces cable tray system using structurally approved anchoring system.

Cable tray system shall maintain a 12" minimum bend radius throughout (no hard 90 degree turns).

Bond cable tray to telecommunications grounding and bonding system.

Provide blind ends where tray termination is exposed.

5.8.3.2 CONDUITS AND BOXES (PRIMARY PATHWAYS)

Each conduit needed for the project is not shown on the plans. Apply the following guidelines in conjunction with conduits shown on the drawings for complete conduit installation.

- Provide (4) 4" conduits from the MDF stubbed out 10ft from the building perimeter for connection to OSP facilities.
- Provide (4) 4" conduits from the MDF to each IDF. Stacked IDFs will have (4) 4" sleeves interconnecting them vertically.
- Provide conduits where ceiling is inaccessible.
- Provide pull boxes as necessary to facilitate proper cable placement, including the following:
- No more than 180 degrees bend between placement points
- No more than 150-200 feet conduit length (depending on the total bend between end points)
- To meet AHJ requirements

    - Provide seismic bracing to conduit systems as approved by the structural engineer.
    - Provide expansion joints and/or fittings to conduit where necessary. Expansion joints/fittings shall be approved by a structural engineer licensed in the state of Washington.
- Label each conduit with permanent labels at both ends and on pull box lids indicating use for telecommunications purposes and the far-end destination.
- Provide fire rated assemblies when penetrating fire rated partitions.
- Paint exposed conduits in the ceiling space to match ceiling color or as directed by the Architect.
- Bond conduits to telecommunications grounding and bonding system

5.8.3.3 USER SPACE PATHWAYS - CABLE HANGERS (SECONDARY PATHWAYS)

Provide cable hangers between primary pathways and work area pathways and/or outlet locations at intervals up to 48 inches on center per a given route, at transitions downward/upward, and within 24 inches of an outlet stub/outlet location.

Provide cable hangers in accessible ceiling areas. In areas with inaccessible ceilings, home run the conduit from the outlet to the nearest cable tray.

Use cable hangers with a closable latch, loop or retainer at the top to prevent cables from falling of the hanger.

Hangers shall be rated for use in air handling spaces.

Use the cable hanger closest to the device conduit stub-out location to support the cable coil slack. Use Velcro style straps to properly manage the coil slack.

5.8.4 CABLING

5.8.4.1 BACKBONE CABLING

Backbone cabling is provided to interconnect the main telecom room with other telecom rooms in a standard star-topology configuration.

Backbone fiber optic cabling will be a will originate from the MDF and terminate to each IDF:

- OM3 multi mode, CMR rated, and with a minimum strand quantity of 24.

All backbone copper cabling will originate from the MDF and terminate on 25 port rack mount patch panels in the IDF:

- 24 AWG, CMR rated, 16 pairs.

5.8.4.2 HORIZONTAL CABLING

Outlets on floors are served by IDF/MDF on the same floor. A telecommunications room will only serve one floor, and a maximum of 20,000sqft .

Each standard telecom outlet receives two cables and a two-port faceplate . The cable configuration for each standard outlet is as follows:

- All cables will be CAT6, CMP (plenum).
- All cables will be U/UTP.
- All cables will have a maximum outside diameter of 0.24in (6.3mm)
- Each cable run shall be a continuous single cable; splices are not permitted.
- Overall jacket color will be white or black (final color TBD).

All CAT6 cabling will be terminated on rack mounted CAT6 rated patch panel.

Terminate cables in patch panels in MDF/IDF.

Maintain a maximum tested cable length of 90 meters (295 feet) from the termination in the telecom room to the termination at the user's outlet faceplate.

5.8.5 LABELING

Label all cables with permanent labels at both ends with the serving telecom room designation and outlet destination.

Final labeling scheme is to be determined, but at minimum outlets should be labeled as follows:

- Serving telecom room
- Rack number
- Patch panel number
- Patch panel port number.

5.8.6 AUDIOVISUAL

Energy Research + Sustainability Center – Feasibility Study

- The following provides a description of audiovisual systems for Cal Poly Humboldt - Energy Research + Sustainability Center in a narrative form
- Audiovisual system descriptions are presented as an assessment for the Owner to determine the design direction in order establish a basis of design.

5.8.6.1 DESIGN CRITERIA AND GOALS

1. STANDARDS:

- General Requirements
  - Audiovisual enabled rooms will be designed to meet the current Cal Poly Humboldt and design standards including AV equipment selection.
  - Refer to California State University TIP Standards Fourth Edition 02-2014

- Reliability:
  - The systems should operate with minimum start-up time, minimum maintenance, and maximum availability based on the features that the selected technology can provide.
- Quality:
  - The video systems will provide high-quality image reproduction.
  - Provide display sizes and placement for student viewing at all seats for each room.
  - Program and speech audio must be clear, intelligible, and of appropriate volume in all spaces.
  - Assisted listening devices (where they are required) must be interconnected with all display systems and must be configured to allow for interconnection to changing technology
- Operation
  - System operation will be simple, intuitive, and provide a consistent control experience in rooms of similar layout and functionality throughout the building. Auto-switching and other methods of automation should be used where possible.
- Expandability
  - Infrastructure and pathway capacity should be designed with expandability in mind to support present and foreseeable user requirements.
  - Each classroom must have the basic infrastructure to support instructor- controlled display and computing equipment, even if the systems will not initially be installed.
- Flexibility
  - AV systems should support various collaboration and instructional methods and have sufficient flexibility to meet emerging instructional trends.

5.8.6.2 AV SYSTEMS DESCRIPTIONS

1. TRAINING LAB / CLASSROOM:

- General: Interactive, classroom-style instruction in a Lab setting
- Display: minimum WUXGA resolution, minimum 8,000 lumen brightness, laser projector and appropriately sized, motorized projection screen OR direct-view LED display at the front of the room; multiple direct view displays at the sides of the room and/or at participant group “pods” (depending on the final design of the space)
- Video: Pan/tilt/Zoom video camera (with software options for auto-tracking) aimed at Instructor; videoconferencing/recording option (USB to instructor PC) for remote student participation; monitor at instructor station to monitor sources and camera angles
- Sources: Owner-furnished computer, laptop input at instructor location, wireless presentation option
- Audio: Content playback via ceiling loudspeakers and wall mounted speakers; lavalier and handheld microphone for speech reinforcement; USB connection to instructor PC for

videoconferencing; assisted listening system

- Control: Touch or button panel for system on/off, volume, source selection located at Instructor station; Typically, an instructor will cue up all media sources before beginning a lecture, placing the equipment in a "hot standby" mode.
- Storage: The teaching station will have a built-in equipment rack and in ceiling enclosure.

2. SEMINAR / WORKSHOP SPACE:

- General: Interactive, configurable space used for lectures and/or Technology Enhanced Active Learning (TEAL) classroom
- Display: minimum WUXGA resolution, minimum 5,000 lumen brightness, laser projector and appropriately sized, motorized projection screen at the front of the room; direct view displays at the sides of the room.
- Video: Pan/tilt/Zoom video camera (with software options for auto-tracking) aimed at Instructor; videoconferencing/recording option (USB to instructor PC) for remote student participation; monitor at instructor station to monitor sources and camera angles
- Sources: Owner-furnished computer, laptop input at instructor location, wireless presentation option; flexible, software-defined routing for wireless input sources for multiple displays throughout the room
- Audio: Content playback via ceiling loudspeakers and wall mounted speakers; lavalier and handheld microphone for speech reinforcement; USB connection to instructor PC for videoconferencing; assisted listening system
- Control: Touch or button panel for system on/off, volume, source selection located at Instructor station; Typically, an instructor will cue up all media sources before beginning a lecture, placing the equipment in a "hot standby" mode.
- Storage: The teaching station will have a built-in equipment rack and in ceiling enclosure.

3. MEDIUM CONFERENCE ROOM:

- General: A meeting room with standard conference- table or a peninsula-style for up to 10 people
    - Display: wall-mounted flat panel display, appropriately sized based on room size and sight lines.
    - Video: Videoconferencing via software-based codec, USB connectivity to a computer; videoconferencing camera/soundbar unit mounted at the display wall
    - Sources: Laptop input at table, wireless presentation option
    - Audio: Content playback via built-in display/soundbar
    - Control: Touch or button panel for system on/off, volume, source selection located at the

table

4. HUDDLE ROOM:

- General: A small meeting room with peninsula-style for up to 4 people
  - Display: wall-mounted flat panel display, appropriately sized based on room size and sight lines.
  - Video: Videoconferencing via software-based codec, USB connectivity to a computer; videoconferencing camera/soundbar unit mounted at the display wall
  - Sources: Laptop input at table, wireless presentation option
  - Audio: Content playback via built-in display/soundbar
  - Control: Touch or button panel for system on/off, volume, source selection located at the table

5.8.7 SECURITY

Energy Research + Sustainability Center – Feasibility Study

- The following provides a description of security systems for Cal Poly Humboldt - Energy Research + Sustainability Center in a narrative form
- Security system descriptions are high level and presented for review and feedback of the Owner to note any additional requirements beyond industry best practices or campus specific requirements.

5.8.7.1 OVERVIEW

This basis of design criteria will cover security systems, including the following:

- Access Control and Alarm Monitoring System (ACAMS)
- Video Surveillance System (VSS)
- Intrusion Alarm System (IAS)
- The security subsystems will also require interfaces to other systems which may include but are not limited to the following building systems:
  - Fire Alarm System
  - Electrical System
  - Door Hardware (electrified)
  - Paging System

5.8.7.2 GOALS AND POLICES

1. GOALS:

- Protection
    - Increase the safety and security of Cal Poly Humboldt students, educators, staff, parents/visitors, and assets
- Flexibility
    - Capable of interfacing with other base building systems, and access through web-based interfaces and mobile applications.
- Scalability
    - Expandable to accommodate additional building security devices.
- Efficient
    - Improve efficient use of other areas of the building for after-hours community events.

2. POLICES:

- Normal Operating Hours
    - Defined as 7:00 AM to 6:00 PM. The building will be controlled during normal operating hours. After-hours access available to Cal Poly Humboldt staff via the ACAMS located at designated entry points. Final policy will be outlined in future versions of this program narrative.
- Staffing
    - Will be defined in future versions of this narrative. It is assumed campus police and security personnel will be available.

3. COORDINATION:

The ACAMS will be integrated with the Division 8 (door hardware). As well as Division 14 (Elevators) with card readers in the elevators.

4. SECURITY SYSTEMS CRITERIA:

The ACAMS will allow Cal Poly Humboldt to manage access to the building perimeter, lobbies, garage, individual levels, and administrative suites, elevators, and base building utility spaces (MDF/MPOE, IDF, Utility Rooms, etc.). The system will generate reports and monitor status of designated points in the facility.

The ACAMS will consist of multi-format (13.56 MHz & 125 KHz) credential readers (mag-stripe, optional, depending on student card system utilized), door monitoring alarm contacts, request-to-exit motion detectors, and interfaces to electrified door hardware at designated locations.

The ACAMS utilizes a client/server topology and communicates across the building LAN/WAN.

This configuration allows future flexibility in monitoring locations, integration with other building systems, and capable of being scaled to support any future security system requirements.

The ACAMS will integrate through software with the VSS system to provide automatic display of an associated VSS cameras based upon a selected ACAMS

The ACAMS will monitor emergency exit only doors utilizing door position contacts and local audible alarms.

Security devices will wire back to security control panels and power supplies located in the nearest IDF Room.

Emergency lock-down functionality will be provided to lock doors in the event of an emergency.

5.8.7.3 VIDEO SURVEILLANCE SYSTEMS (VSS)

Cal Poly Humboldt has a minimal approach to video surveillance systems so care must be used in placing cameras only where deemed absolutely necessary.

The building video surveillance system will consist of High Definition (HD) IP fixed and 360-degree cameras selectively located to minimize appearance and quantities of cameras.

VSS fixed camera views will be recorded for a minimum of 30 days at 15 frames-per-second and at a minimum resolution of 2 Megapixels (1920x1080P).

VSS 360-degree camera views will be recorded for a minimum of 7 days at least 15 frames-per-second per imager and at a minimum resolution of 8 Megapixels. The cameras will have four imaging sensors.

Video Surveillance Cameras will be managed and recorded by a video management system that can be deployed using a commercial off the shelf server located in the MDF/MPOE room or through a Cal Poly Humboldt server located elsewhere.

Archival storage retrieval and live viewing of camera views can be done on security client workstations located at the lobby, private offices, or remotely via the internet (with authorized credentials).

Security cameras will utilize telecommunications category cable to the nearest IDF room and connect to commercial grade PoE switches.

The following table shows the proposed video surveillance locations:

Area	Coverage	Field of View
Building Exterior	Yes	General overview of the perimeter of the building.
Building Entry/Exits	No	-
Lobby	No	-
Corridors	No	-
Elevator Cabs	No	-
Stairwells	No	-
Classrooms	No	-

5.8.7.4 INSTRUCTION ALARM SYSTEMS (IAS)

In order to notify security and police of unauthorized entrances when the building is unoccupied, an intrusion alarm system will be provided.

This system utilized a combination of motion and glass-break sensors which are connected back to an alarm system control panel.

The system can be deactivated by a keypad or, by authenticated access via the ACAMS.

The system will alert Cal Poly Humboldt 's central monitoring service.

5.8.7.5 LIGHTING RECOMMENDATIONS

The success of any security program critically depends on the presence and amount of exterior lighting. During nighttime operation, exterior lighting provides:

Illumination to allow the proper operation of the exterior Video Surveillance System (VSS) camera system.

A sense of security to Cal Poly Humboldt staff and students using the building.

Site lighting design shall meet all City and local building codes.

Minimum lighting levels as recommended by the IES and by VSS camera manufacturers consist of:

- Building perimeter – 1 foot-candle (10 lux)
- Entrances – 5 foot-candles (50 lux)
- The average to minimum uniformity ratio shall not exceed four to one

Exterior lighting shall operate continuously during hours of darkness in these areas:

- Building perimeter
- Building entrances

5.8.8 WI-FI / NETWORK

Energy Research + Sustainability Center – Feasibility Study

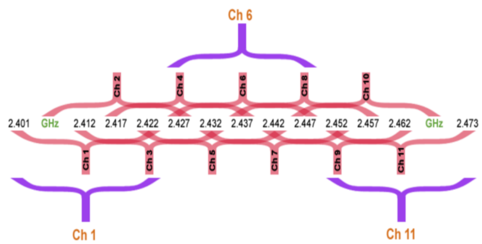
- The following provides a description of audiovisual systems for Cal Poly Humboldt - Energy Research + Sustainability Center in a narrative form

5.8.8.1 OVERVIEW

An enterprise wireless network shall be provided for the new Jameson building. These access points (APs) in conjunction with wi-fi controllers will provide 802.11ac (Wi-Fi 5) coverage for both Cal Poly Humboldt staff, student, vendor, and guest wireless connectivity. Wireless coverage will include all interior spaces with the exception of the parking garage areas.

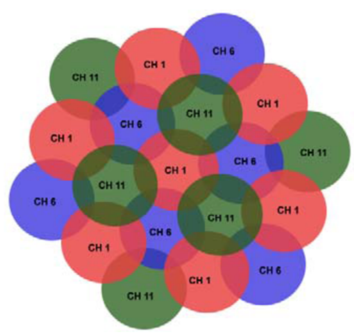
5.8.8.2 REQUIREMENTS

802.11abg and n support 14 channels, each one 22MHz wide. In the USA and Canada, channels 1 through 11 are allowed. Each of these channels overlaps significantly with their neighboring channels and somewhat with their neighbor's channels. The only four non-overlapping channels are 1, 6 and 11 as shown below.



Industry best practice recommends that the channels for each AP be set such that their signals do not overlap with other APs on the same channel if possible. This will minimize interference (channel overlap) between APs. If all APs are set to the same channel, the system will in most cases still work. However, because each AP will interfere with each other, throughput is likely to be degraded and will be unacceptable for Cal Poly Humboldt's deployment of wireless.

The recommended channel strategy will be implemented similar to the following diagram:



Support for 802.11ax (Wi-Fi 6) will be required, with Wi-Fi 6E (utilizing the 6GHz spectrum) to also become used in the future. This technology has significant performance features such as multiple-user + multiple-input / multiple-output (MU-MIMO), channel bonding, and Orthogonal frequency-division multiple access (OFDMA). Because the 2.4 GHz spectrum is limited in frequency bands. It is recommended that Wi-Fi 6 be implemented within the 5 GHz spectrum to allow for channel bonding without interfering with non-bonding channels.

Cal Poly Humboldt will retain the wireless survey model and data internally for future modifications and adjustments. Hence the predictive, passive, and active survey data will be included within the as-built documentation.

An example predictive model signal strength heat-map.

A few considerations and criteria for the future wireless deployment:

- Mobile computers will be deployed
- Expanded use of VoIP over wireless
- Support 802.11ax (Wi-Fi 6) features such as MIMO, channel bonding and OFDMA.
- 1 AP per 1,500 sq. ft

Manufacturers:

- Cisco Aironet 4800

5.8.9 DAS-ERRCS

Energy Research + Sustainability Center – Feasibility Study

- The following provides a description of audiovisual systems for Cal Poly Humboldt - Energy Research + Sustainability Center in a narrative form

5.8.9.1 DISTRIBUTED ANTENNA SYSTEMS (DAS)

An optional Distributed Antenna System (DAS) will consist of a head end that houses a wide band transceiver located in the MDF (or dedicated DAS room). This head end system will be a common interface node; collocated with signal source equipment for wireless service providers. Integration with these providers will be turnkey and include antenna, cabling, mounts, equipment installation and integration with all wireless systems. This system is not code-required, and it is to be determined if it will be included as part of this project.

The transport medium for DAS can take many forms, from traditional off-air repeater, small cell, or Base Transceiver Station (BTS) connected to architecture consisting of coaxial, fiber optic, or hybrid fiber/ coaxial solution.

For a building of this size, and campus considerations, there are two recommended approaches to the DAS.

- Small cell (sometimes referred to as "cloud-based") source injected into a hybrid passive/active DAS.
- Base-station transceivers co-located with owner DAS equipment.

Small cell source consists of an Internet connected device which communicates with wireless service providers servers to receive a wireless signal which is then output either by the small cell device itself, or, by connecting its antenna outputs to a passive/active DAS. This is suitable for projects where the off-air source is too weak and distributing the signal within the building would not provide any noticeable increases in the quality of service.

Base-station transceivers consist of carrier provided cabinets that house all of the signal origination equipment that would commonly be found either at a cell tower "hut" or at the carriers central office. This equipment receives a fiber connection from the carrier, and then the signal is outputted via coaxial jumpers into the Point of Interface (POI) cards of the owner's DAS.

Since the building is less than 15,000 sq. ft., it is recommended that either, A: an off-air repeater system be provided if the building is to be stand-alone. Or, B: a campus DAS head-end is created (or an existing one connected back-to).

If a base-station head-end is created, then this would then become the head-end for the entire campus feeding all buildings carrier signals.

1. PASSIVE DAS COMPONENTS:

The passive DAS architecture is comprised of three main elements, the wireless portal, the vertical riser cable or feeder, and the horizontal cable that connects to antennas.

The wireless portal is the DAS head-end that receives signal sources. This portal consists of a combination of band pass filters and combiners. These signals are summed and provide a single common output. The function of these lumped devices is to precondition the input signals, balance input signal levels, combine them with minimum loss, and feed them into one common wide frequency band spectrum output.

The combined output port is connected to the riser feeder cable that runs vertically transporting the combined signal throughout the building.

High precision broadband "taps" and splitters are used to extract the combined signals at each floor. The combined signal is power divided, or coupled with the Horizontal cable distribution system for that particular floor area.

Based on the physical obstruction of signals and building design of each floor, the floor area is divided into coverage segments (typically 5,000 to 7000 square feet). The horizontal cable distribution system is deployed with multiple broadband antennas in a predetermined fashion (based on predictive modeling in software) providing a custom design unique to the floor. This design will provide the required area coverage segments, capacity and signal levels throughout the floor.

The passive DAS network does not require any monitoring or control equipment to maintain coverage and service. The system is grounded at the portal and on each floor at the Riser cable with building ground.

2. ACTIVE DAS COMPONENTS:

The Active DAS architecture is comprised of three main elements, the Master Unit, the Fiber Optic Transport (Radio over Fiber), and the Remote units.

The system's basic function is to extend the coverage beyond what could typically be carried by a passive DAS only. Or, where long runs of bulky and inflexible "hard-line" coaxial riser cables are impractical.

The Master unit is DAS head-end that receives signal sources. This system consists of a series of band pass filters specially tuned to a specific carrier frequency, bidirectional amplifiers for the uplink and downlink signals, where they feed to a media converter subsystem module (Radio over Fiber).

The uplink and downlink signals are transported over Fiber to the Remote Units that could be located anywhere in the building, and the signal loss is insignificant.

At the Remote Unit the signal is distributed over traditional passive DAS infrastructure (splitters, taps, coaxial cable, antennas, etc.).

3. SUPPORTED SIGNALS:

The DAS shall be designed to support the following systems and frequencies:

Wireless Operators: Verizon, AT&T, T-Mobile/Sprint

- LTE (700 MHz) - Verizon (4G)
- Cellular (850 MHz) - AT&T, Verizon (2.5G & 3G)
- PCS (1900MHz) - Verizon, T-Mobile/Sprint (2.5G & 3G)
- AWS (1700/2100 MHz) - AT&T, T-Mobile/Sprint (3G /4G LTE)

4. DISTRIBUTION AREAS:

The System shall distribute radio-frequency (RF) coverage at levels outlined below in the following areas of the building(s) – herein specified coverage areas:

All floors and areas including:

- Stairwells
- Elevators
- General Use spaces (break rooms, staff rooms)
- Restrooms
- Classrooms
- Large gathering spaces
- Circulation

5. ADDITIONAL REQUIREMENTS:

The system shall have the capability for separate control over each service (or wireless operator) to allow the ability to adjust and control power levels without disturbing other services/operators.

The system shall support multiple services in a modular architecture so services can be added or removed without requiring new infrastructure, without readjustment of signal power levels, or disturbing existing services.

The system shall enable services to be added without requiring additional cable plant or antenna systems.

The system shall not impede any management features or functionality of any attached network and/or device management system. The System shall allow for proactive management and end-to-end alarming of active electronics. The System shall be able to engage with 3rd party SNMP-based element management systems and provide fault management information.

The DAS network shall support the use of legacy cellular enhancement and technologies such as GSM, EDGE, and UMTS-HSPA technologies.

The DAS must be FCC certified and in compliance with FCC's and regional regulatory authority's emission rules for wireless devices.

5.8.9.2 EMERGENCY RESPONDER AUDIO COVERAGE SYSTEMS (ERRCS)

A code-required (Chapter 510 of the CFC) ERRCS shall be provided.

This is a wholly separate DAS from cellular carriers and is provided to extend the coverage of emergency responder radio signals throughout the building.

The infrastructure of the ERRCS is nearly identical to cellular DAS as described previously in this narrative with the exception that the ERRCS is almost always an off-air source system.

1. REQUIREMENTS:

All channels shall be -95 dBm or stronger as specified by any local ordinance.

The ERRCS will support the following local systems:

- CAL FIRE 450MHz
- Humboldt County Sheriff (150MHz / 450MHz)
- Cal Poly Humboldt (150MHz)

Currently, the existing systems are legacy LMR systems. The ERRCS shall not only accommodate these legacy systems, but also the latest advancement in 2-way communication radio systems, such as the P25 project, which is an IP based simulcast network that supports both digital, and analog 2-way communication systems.

The ERRCS riser pathways and head-end equipment must be protected by 2-hour rated assemblies. In addition, the head-end equipment must be contained in a NEMA 4 enclosure to protect it from sprinkler or fire hose water sources so that in the event of a fire emergency responders and still use the in-building ERRCS.

Due to the more complicated construction assemblies involved in a 2-hour rated pathway, it is recommended that the ERRCS riser stack vertically in order to reduce any horizontal runs of backbone cabling. Such horizontal runs may require either custom 2hr rated soffits, or fire-wrapped conduits in order to protect the cabling.

It is also recommended that the ERRCS head-end receive its own room at the top floor of the building to reduce the length of passive coaxial cabling that connects from antennas on the roof of the building to the ERRCS head-end unit. Typically, a small 6' by 6' closet is all that is required to house this equipment. This closet's construction assemblies shall be 2-hour rated.

The ERRCS shall also have its system status connected to the building's fire alarm system so that it can be monitored in the event any fault in the ERRCS occurs. If a fault occurs the fire alarm systems annunciator panel will be triggered to show the fault.

The ERRCS must be FCC certified and in compliance with FCC's and regional regulatory authority's emission rules for wireless devices, as well as approved by the local authority having jurisdiction (AHJ).

5.9 LIGHTING

Lighting for the Energy Research and Sustainability Center seeks to reinforce a high level of efficiency and simplicity. To this end, lighting will focus primarily on illumination for the highly functional requirements of the spaces while offer flexibility for various scenarios. Lighting systems will also aid in the user experience with added focus on common areas such as the lobby and clarifying wayfinding throughout. Light fixture

selection will also consider visual comfort, maintenance, economic value, and sustainability.

5.9.1 INTERIOR LIGHTING SYSTEMS

The lighting system and controls for the interior spaces throughout the building will target the following attributes:

- Luminaires throughout the building will be LED type, 3500K CCT, 90 CRI, with lumen packages selected to provide light level in accordance with the recommendations of the Illuminating engineering Society of North America (IESNA) handbook and recommend practice guides and local ordinances.
- All lighting shall be LED with dimmable drivers.
- Storage and unfinished areas will be provided with 2' x 4' standard lensed troffers or industrial type strip fixture.
- Emergency egress lighting: selected light fixtures shall be connected to the generator system to provide egress lighting along the egress paths in accordance with California building code. 1.0 FC average, 0.1 FC minimum, 40:1 uniformity ratio.
- Illuminated exit signs will also be used along the path of egress, allowing a sign to be seen at any one time. Exit signs will be LED and UL listed with red lettering and an operating voltage of 277-volts.

Illumination Design Criteria:

Area	Illumination Levels
Reception	15fc at 3.5 ft
Resource/ Library	20fc at floor
Work Room	10fc at floor, 30fc at task
Kitchenette/ Breakroom	20fc at task
Wellness	10fc at 2.5ft
Seminar/Classroom	40fc at 2.5ft
Conference	30fc at 2.5
Huddle	30fc at 2.5
Private Office	30fc at task
Open Office	30fc at task
Labs	50fc at 3ft, 75fc at 3ft demonstration
Data Center	10fc at floor, 50fc at 2.5ft task plane
Storage	20fc at floor

Reception:

Recessed LED wall washers will provide vertical brightness by highlighting accent walls, further defining the space. Narrow beam LED downlights will be recessed into the ceiling of the atrium to provide a functional layer of lighting that does not interfere with architectural design gesture or create glare issues. Low profile LED downlights will provide functional lighting levels for the transition area. Where ceiling changes occur, surface mounted LED cove fixtures concealed within an architectural cove will highlight the ceiling.

Resource/Library:

Continuous linear pendant fixtures will provide direct and indirect light to functionally illuminate work areas. Additionally, linear pendant fixtures will functionally illuminate shelving.

Work Room:

Linear recessed light fixtures provide general lighting to the space. Under cabinet lighting will be provided to increase function light levels at counter/task plane.

Kitchenette/Breakroom:

Linear recessed light fixtures provide general lighting to the space. Under cabinet lighting will be provided to increase function light levels at counter/task plane. Additionally recessed wall wash fixtures will accent strategic walls.

Wellness:

Continuous perimeter wall slot will provide functional illumination at counter. Decorative pendant light will provide ambient fill light to the space. Dimming control will be provided for user control of room brightness.

Seminar/Classroom:

Continuous pendant direct indirect light fixtures will provide ambient and task lighting at desks. Teaching walls will be illuminated with recessed linear wall wash fixtures and controlled from separate switch.

Conference:

Recessed louvered linear fixtures will provide functional task illumination at table. Perimeter walls will be uniformly washed with recessed baffled wall wash fixtures.

Huddle:

Wall mounted direct and indirect light fixtures will provide task illumination on work surface as well as ambient fill light on ceiling. Baffled downlights will provide additional light as needed.

Private Office:

A task-ambient lighting approach will be utilized to reduce energy and provide individual control. The ambient system will be comprised of pendant mounted direct/indirect LED fixtures. Furniture mounted LED under-cabinet or free-standing LED task light fixtures will provide elevated lighting levels at the work plane.

Open Office:

A task-ambient lighting approach will be utilized to reduce energy and provide individual control. The ambient system will be comprised of pendant mounted direct/indirect LED fixtures. Furniture mounted LED under-cabinet or free-standing LED task light fixtures will provide elevated lighting levels at the work plane.

Labs:

A task-ambient lighting approach will be utilized for lab spaces. The lighting system for this space will primarily utilize direct/indirect pendants centered between benches to provide the ambient lighting layer. The task system will vary depending on the lab bench type. For typical lab benches, under-cabinet LED task lights will be used to enhance lighting levels at the work plane. For open benches recessed adjustable spot fixtures located in the ceiling directly above the bench will provide enhanced lighting levels.

Data Center:

Recessed linear lights will provide high functional light levels where needed for equipment service. Standard industrial pendant mounted strip lights will be provided where no ceilings occur, and no regular equipment service occurs.

Storage:

Standard strip light fixtures will be provided where no ceiling occurs. Recessed lensed linear fixtures will be provided where ceilings are placed.

5.9.2 EXTERIOR LIGHTING SYSTEMS

The lighting systems and controls for the exterior will target the following attributes:

- Fixtures throughout the site and building exterior will be LED type, 3000K CCT, with lumen packages selected to provide light level in accordance with the recommendations of the Illuminating Engineering Society of North America (IESNA) handbook and recommended practice guides and Local Ordinances.
- All exterior light fixtures must utilize marine grade materials, copper free alloys, fully gasketed IP65 enclosures, marine rated powder coating, and stainless-steel hardware with stainless-steel inserts where applicable. Ground mounted flood lights shall be brass construction and naturally finished.
- MLO LZ3 will be used for outdoor lighting ordinances and for determining light pollution reduction targets.
- All exterior lighting will be selected to meet the LEED light pollution reduction credit for MLO LZ3 and align with International Dark-sky Association (IDA) recommendations.
- Light pollution reduction will also be addressed via controls and a curfew based on programmatic requires. Occupancy based site lighting controls will be used where possible
- LED wall packs will be used above exterior doors connected to emergency power circuit.

- LED pole mounted fixtures on 12′-15′ poles will be used for pedestrian walkway lighting.
- Pole mounted LED lighting fixtures will be used for roadways. Poles will be round tapered aluminum, 20′-25′ high with single or double arm mounted fixtures.

Illumination Design Criteria:

Area	Illumination Levels
Roadway	2.0fc avg. 0.9fc min., 4:1 avg./min.
Pedestrian Path	0.5fc min. and 1.0fc avg.
Entry	1.0fc min.
Terrace/ Open area	0.5fc min. and 1.0fc avg.
Outdoor Labs	10fc min.

Building Exterior/Facade:

Main building entries will be accented to provide an increased sense of wayfinding to denote main entry points to facility. Building exterior overhangs will be accented with soft up light to highlight building massing and stacking. Up lighting will be contained within overhang to eliminate light pollution. Building façade lighting will be curfew controlled.

Outdoor Lab:

Building mounted asymmetric floods lights will provide elevated work lighting throughout the outdoor lab. Light fixtures will be full cutoff to minimize light pollution. Fixtures will only provide elevated light levels upon user input to further limit light pollution and reduce energy consumption.

Outdoor Solar Lab:

Pole mounted area lights will provide elevated work lighting throughout the outdoor solar lab. Light fixtures will be full cutoff to minimize light pollution. Fixtures will only provide elevated light levels upon user input to further limit light pollution and reduce energy consumption.

Terrace:

The terrace will utilize a combination of typical pedestrian area pole lights, linear bench integrated continuous under glow, and strategic landscape accent with ground mounted floodlights.

5.10 ACOUSTICS

The following section provides a summary of the relevant acoustical criteria and acoustical recommendations for the "Energy Research + Sustainability Center" building. The focus of this section is:

- Sound Isolation: Coordination of interior partitions to reduce airborne noise transfer between spaces as well as structure borne (e.g., footfall, machinery) noise.
- Room Acoustics: Coordination of acoustically absorptive finishes to meet the reverberation time requirements and support clear speech and hearing within spaces as well as reducing noise build-up.
- MEP Noise and Vibration: Coordination of mechanical, electrical, and plumbing (MEP) designs to meet ASHRAE's recommended HVAC noise criteria.

5.10.1 CRITERIA

The California State University (CSU) Guidelines and Standards does not contain acoustical criteria. The following criteria is based on similar California State University projects, industry standards, ANSI Standard S12.60, LEED, and ASHRAE guidelines.

- CalGreen Section 5.507 "Environmental Comfort," stipulating a maximum Leq of 50 dBA inside of occupied hours due to exterior (environmental noise).
- All indoor academic and academic support spaces shall meet the requirements as described in LEED for New Construction – Indoor Environmental Quality Credit: Acoustic Performance, including both HVAC Background Noise and Sound Transmission Standards.
- All core learning and ancillary learning spaces shall meet the requirements as described in ANSI Standard S12.60-2010 – Performance Criteria, Design Requirements and Guidelines for Schools, Part 1: Permanent Schools.
- Exterior Noise Control: Project-generated noise shall comply with State and local City noise ordinances.

LEED v4.1, ANSI Standard S12.60-2010, and ASHRAE's guidelines contain quantitative acoustical criteria for schools and office space.

-

Space	Room Acoustics	Sound Isolation	Background Noise [a]
Classroom/Teaching Lab ($10,000\ ft^3$ or less)	Maximum Reverberation Time: 0.6 seconds	**Airborne Noise** STC 45: Adjacent to corridor, stairwell, office, or conference room. STC rating does not include doors (doors to be STC 30). STC 50: Adjacent to other classrooms/labs or similar spaces requiring a high degree of acoustical privacy STC 55: Adjacent to restrooms STC 60: Adjacent to MEP equipment room/IT room [b] **Impact Noise** IIC 45: When a classroom/lab is above a core learning space IIC 40: When a classroom/lab is above an ancillary learning space **Maximum Hourly L_{eq} due to Exterior Noise Sources** 35 dBA	NC: 30 35 dBA
Lecture/Seminar Classroom (above $10,000\ ft^3$, less than $20,000\ ft^3$)	Maximum Reverberation Time: 0.7 seconds		NC: 30 35 dBA
Lecture/Seminar Classroom (above $20,000\ ft^3$)	Recommended Reverberation Time: 1.0 seconds; wall panels as well as ceiling absorption required		NC 30 / 35 dBA with speech amplification; NC 25 / 30 dBA w/o speech amplification
Labs	Maximum Reverberation Time: 1.0 seconds		NC 35 40 dBA
Corridors	No requirement, recommend reverberation time of 1.2 seconds or less		NC: 40 45 dBA
Conference Rooms/Seminar/Workshop Space	Incorporate acoustically absorptive ceiling (NRC 0.80 minimum) or maximum reverberation time of 0.6 seconds	**Airborne Noise** STC 40: At corridors (with door) STC 50: Between adjacent conference rooms/huddle/private offices/shared offices/break room/stairwell/open plan/occupied spaces/corridor STC 55: At restrooms STC 60: Adjacent to MEP equipment room/IT room [b] **Impact Noise** IIC 45 **Maximum Hourly L_{eq} due to Exterior Noise Sources** 40 dBA	NC: 30 35 dBA
Huddle/Private Office/Wellness/Library/Resource Center/Lactation	Incorporate acoustically absorptive ceiling (NRC 0.75 minimum) or maximum reverberation time of 0.6 seconds	**Airborne Noise** STC 35: At corridors (with door) STC 45: Between adjacent huddle/private offices/shared offices/break room/stairwell/open plan/occupied spaces/corridor STC 55: At restrooms STC 60: Adjacent to MEP equipment room/IT room [b] **Impact Noise** IIC 40 **Maximum Hourly L_{eq} due to Exterior Noise Sources** 40 dBA	NC: 30 35 dBA
Shared Workspace/Shared Offices	Incorporate acoustically absorptive ceiling (NRC 0.75 minimum) or maximum reverberation time of 0.6 seconds	**Airborne Noise** STC 35: At corridors (with door) STC 45: Between adjacent huddle/private offices/shared offices/break room/stairwell/open plan/occupied spaces/corridor STC 53: At restrooms	NC: 35 40 dBA

Table 5.10.1 Acoustical Criteria

Space	Room Acoustics	Sound Isolation	Background Noise [a]
		STC 60: Adjacent to MEP equipment room/IT room [b] **Impact Noise** IIC 40 **Maximum Hourly L_{eq} due to Exterior Noise Sources** 50 dBA	
Open Plan/Waiting Areas	Incorporate acoustically absorptive ceiling (NRC 0.80 minimum) or maximum reverberation time of 0.8 seconds	**Maximum Hourly L_{eq} due to Exterior Noise Sources** 50 dBA	NC: 40 45 dBA
Work Rooms/Copier/Breakroom	Incorporate acoustically absorptive ceiling (NRC 0.75 minimum) or maximum reverberation time of 0.6 seconds	STC 35: At corridors (with door) STC 45: Adjacent to huddle/private offices/shared offices/break room/stairwell/open plan/occupied spaces/corridor. STC 50: Adjacent to conference, classrooms/labs or similar spaces requiring a high degree of acoustical privacy **Maximum Hourly L_{eq} due to Exterior Noise Sources** 50 dBA	NC: 40 45 dBA
Reception/Lobby/Entry	Incorporate acoustically absorptive ceiling (NRC 0.80 minimum) or maximum reverberation time of 1.0 second	**Maximum Hourly L_{eq} due to Exterior Noise Sources** 50 dBA	NC: 40 45 dBA
MEP Rooms/Data Center/IT Room	Incorporate acoustically absorptive ceiling (NRC 0.75 minimum)	STC 40: At corridors STC 60: Adjacent to acoustically sensitive space [b]	--
Bathrooms/Kitchen	--	STC 40: At corridors STC 55: Adjacent to acoustically sensitive space	NC: 40 45 dBA

Table 5.10.1 Acoustical Criteria

* Background noise level from exterior sources (e.g., traffic noise, outdoor mechanical equipment) as well as continuous interior sources (e.g., fan coil units, VAV boxes, etc.). Equipment such as fume hoods and other intermittent devices may be louder if they are user-controllable (i.e., they can be turned off). Both A-weighted (dBA) and NC criteria are presented, as dBA is easier to measure/utilize during commissioning/post-construction measurements.
* If it can be demonstrated that equipment in the MEP and IT/Data Center room meets the background noise limits specified in the adjacent space, STC rating of wall can be reduced to no lower than STC 45.

5.10.2 RECOMMENDATIONS

5.10.2.1 PARTITION SOUND ISOLATION

Airborne sound isolation is the amount of noise reduction afforded by constructions (doors, windows, partitions, floor-ceiling, etc.). Constructions with high levels of noise reduction, such as concrete walls, are described as providing greater amounts of airborne sound isolation. Sound isolation recommendations are expressed in terms of laboratory STC rating.

To achieve the STC ratings listed in the criteria section above, sound-rated partitions will be necessary. The field-measured Noise Isolation Class (NIC) value of the installed wall assembly shall not be more than 5 decibels below the STC rating of the demising assembly.

We have found that partitions with fewer layers of gypsum board incorporating "acoustical" studs, staggered studs, or double-stud assemblies may cost less than single-stud partitions with multiple layers of gypsum board. We recommend the Cost Estimator provide input on the most efficient partition design. Schematic details for each STC rating are provided as follows:

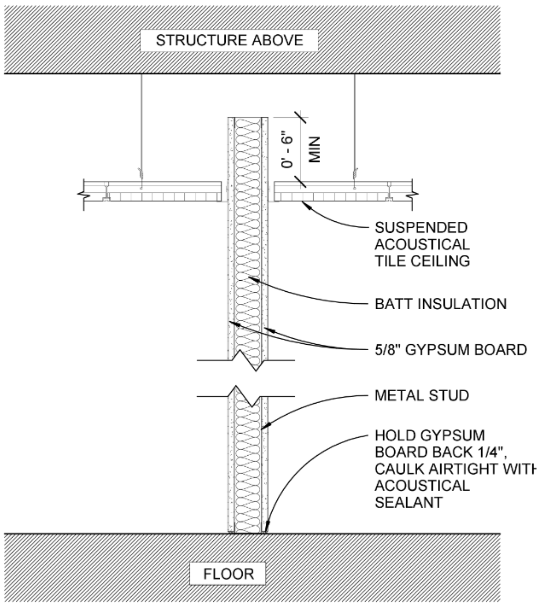


Figure 5.10.2.1 STC 35 Partition

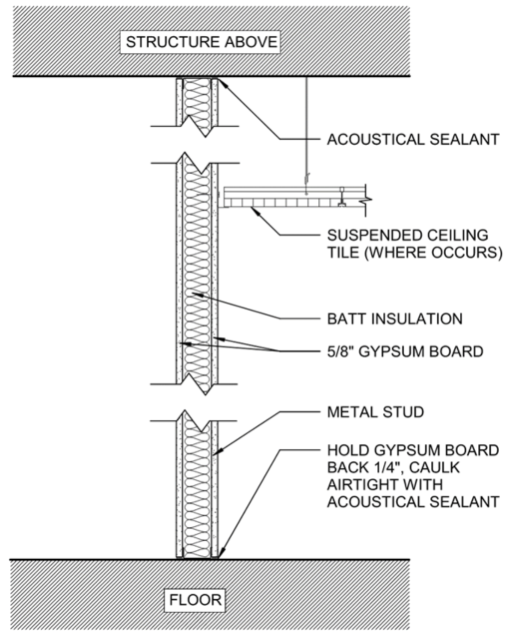


Figure 5.10.2.2 STC 40 Partition

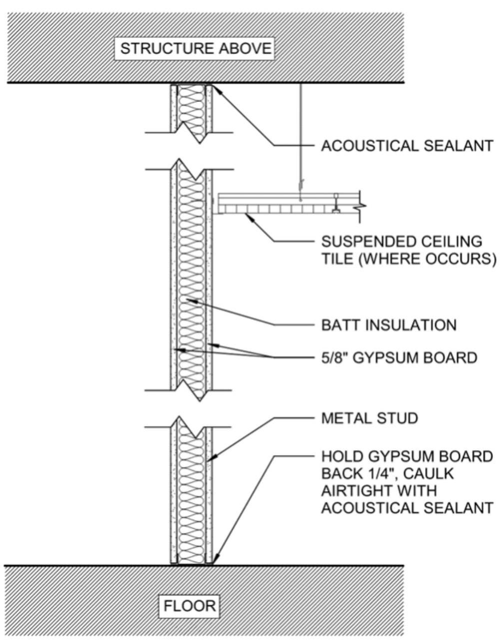


Figure 5.10.2.3 STC 42 Partition

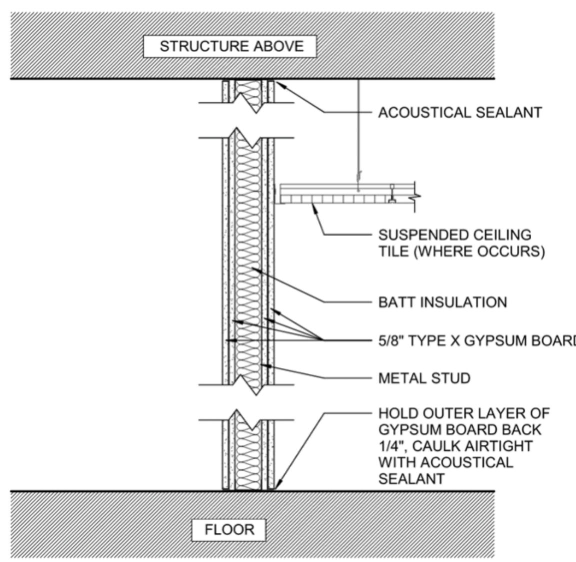


Figure 5.10.2.4 STC 45 Partition

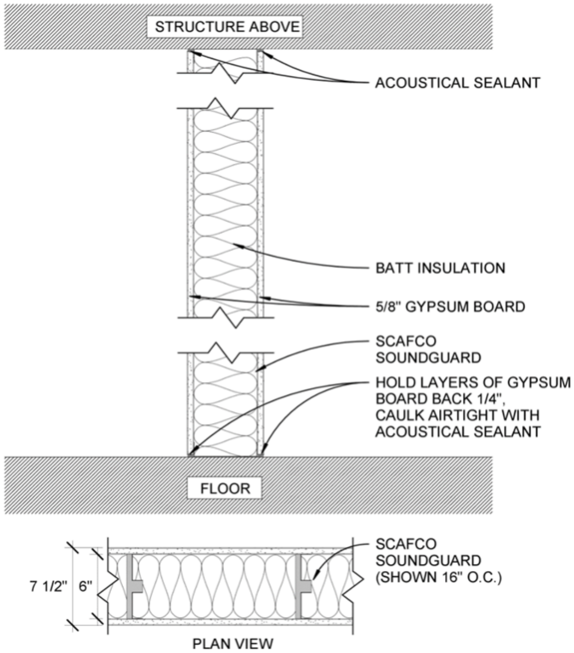


Figure 5.10.2.5 STC 50 Acoustic Stud Partition

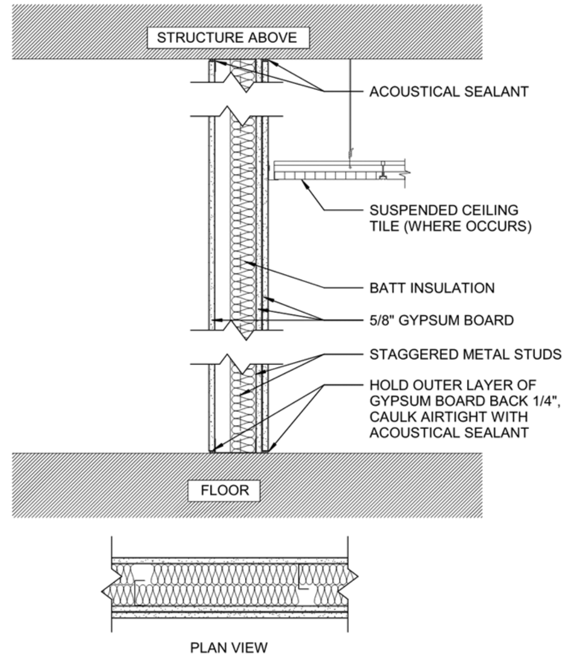


Figure 5.10.2.6 STC 50/53 Staggered Stud Partition

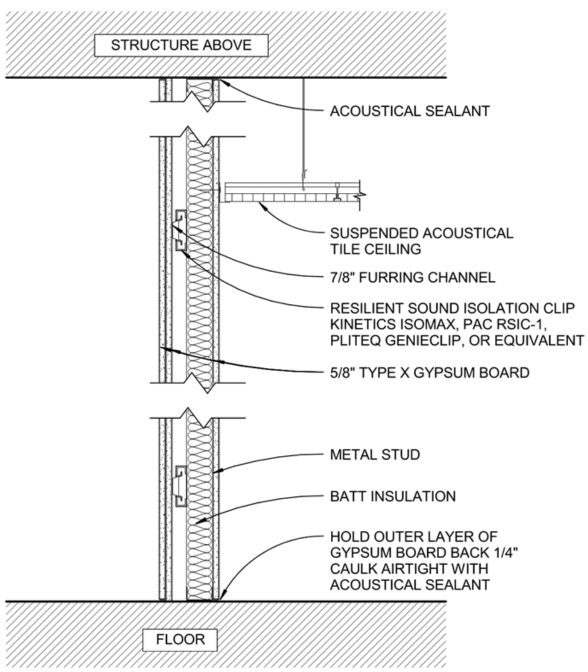
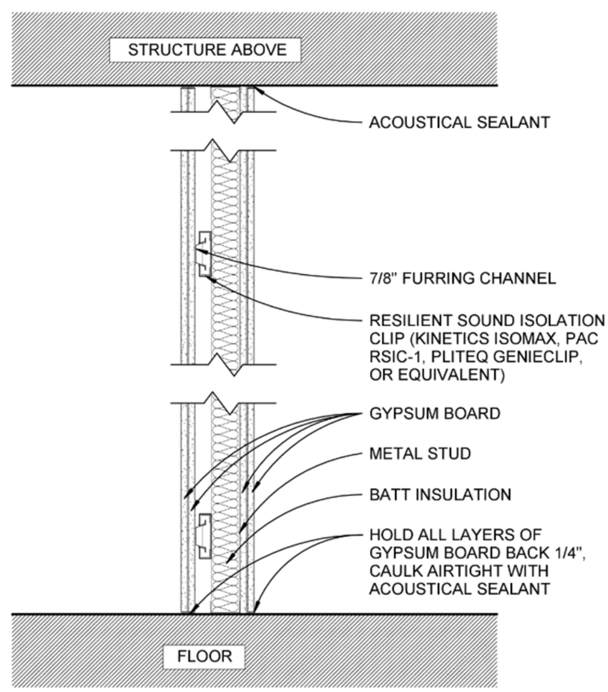


Figure 5.10.2.7 STC 50/53 Acoustic Clip Partition



NOTE: RESILENT CLIP MANUFACTURER'S INSTALLATION GUIDELINES SHOULD BE FOLLOWED.

Figure 5.10.2.8 STC 55 Acoustic Clip Partition

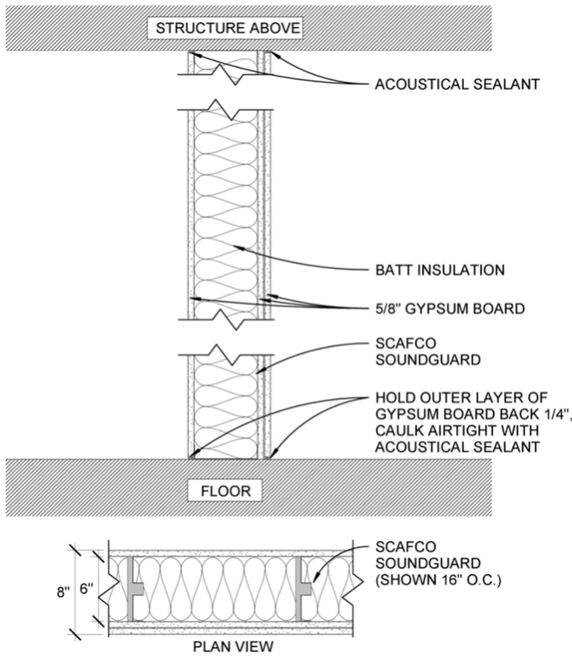


Figure 5.10.2.9 STC 55 Acoustic Stud Partition

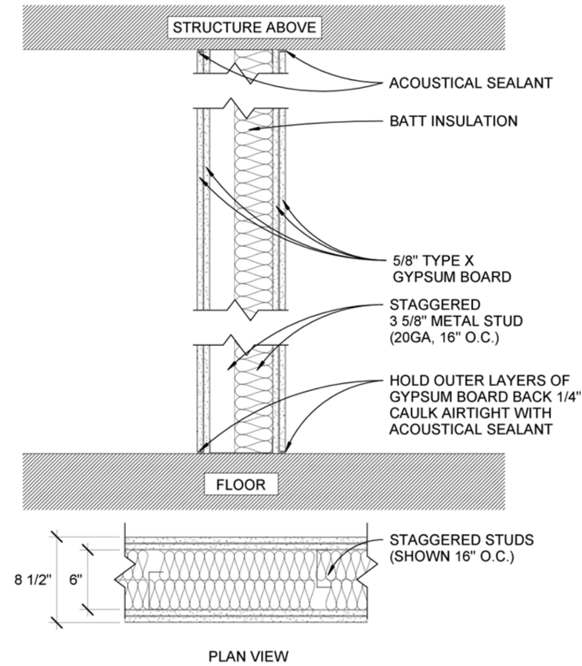


Figure 5.10.2.10 STC 55 Staggered Stud Partition

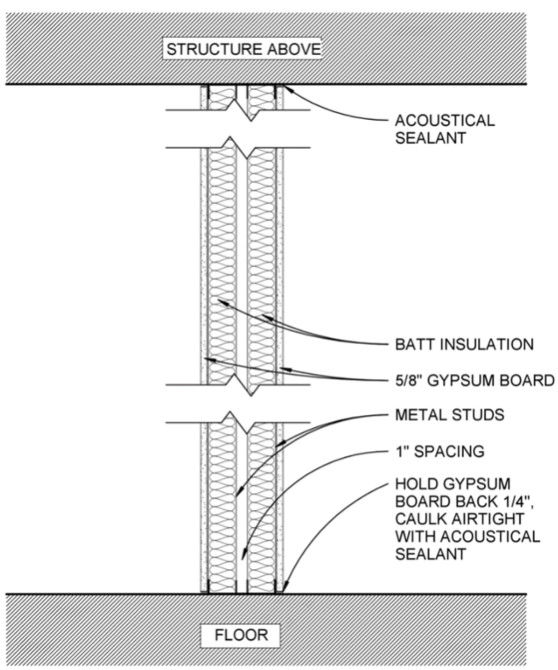


Figure 5.10.2.11 STC 55 Double-Stud Partition

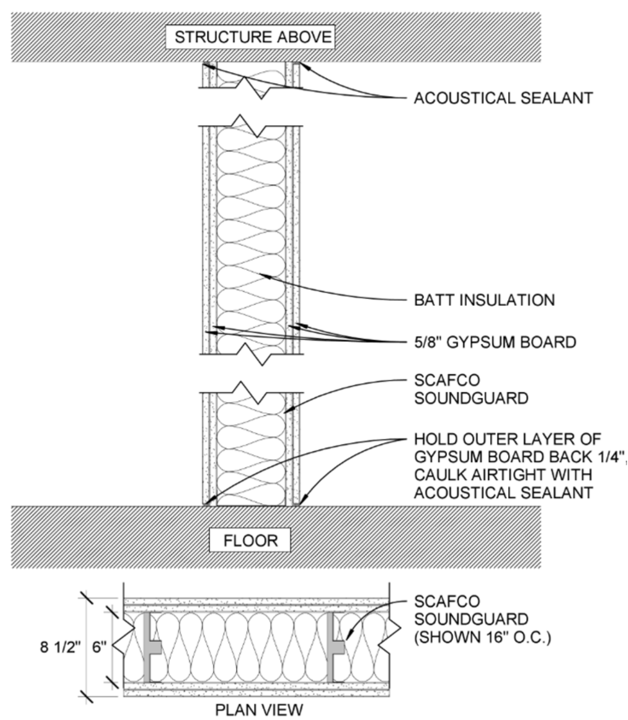


Figure 5.10.2.12 STC 60 Acoustic Stud Partition

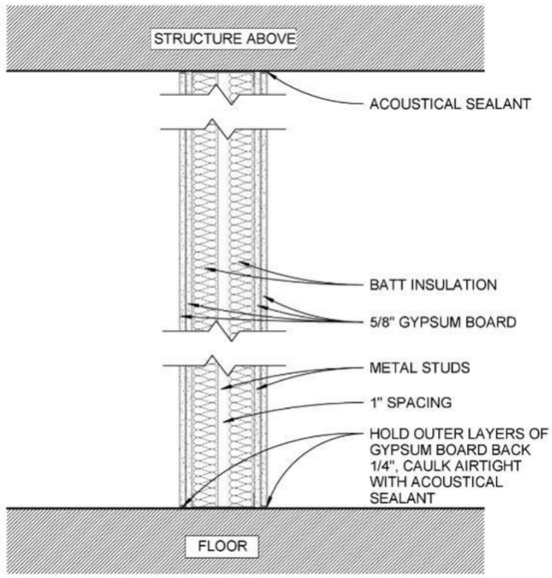


Figure 5.10.2.13 STC 60 Double-Stud Partition

Sound-Rated partitions shall follow these guidelines:

- Offset gypsum board layer seams by 24". Mud and tape all joints between gypsum board layers.
- Provide full depth insulation in all stud cavities; do not compress insulation.
- Hold back the face layer of gypsum board ¼" from intersecting surfaces and caulk airtight with non-hardening resilient acoustical sealant.
- Minimize the number of penetrations in sound-rated partitions.
- Oversize full perimeter of penetrations (maximum ¼" gap) to avoid direct contact between the penetrating element and partition framing elements and layers. Seal all penetrations with closed cell foam backer rod, if necessary, and non-hardening, resilient acoustical sealant.
- Rough-in boxes should be fully backed with putty pads (minimum ¼"-thick intumescent clay pads).
- Rough-in boxes should not be placed back-to-back; offset boxes by a minimum of 16" horizontally.
- Seal gaps airtight where full height walls meet structural decks above (see following section).

5.10.2.2 PARTITION SOUND ISOLATION SPECIALTIES

Partitions at shafts, MEP rooms, Data Center / IT Rooms, IDF rooms, and other noise emitting rooms should be evaluated and recommended STC ratings should be refined as the equipment is scheduled and noise calculations are completed.

Some sound-rated partitions that terminate at the exterior windows can be an acoustical "weak link" in the wall assembly and will compromise the performance of the demising partition. The intersection should be treated with an acoustical mullion product such as the Mull-it-Over, Emseal QuietJoint, or Piedmont Plug products.

The acoustical treatment of penetrations, partition intersections, and outlet boxes is critical to achieve the STC ratings presented in the Criteria section. The following details should be incorporated into the architectural drawings and noted on the floor plans, sections, etc., as appropriate.

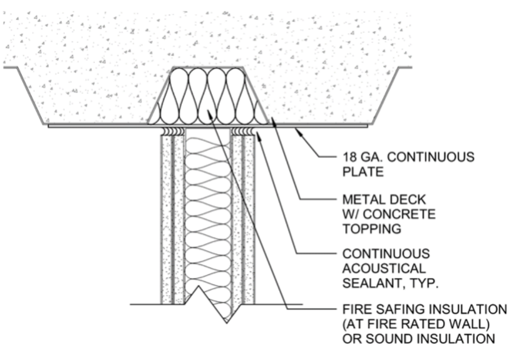
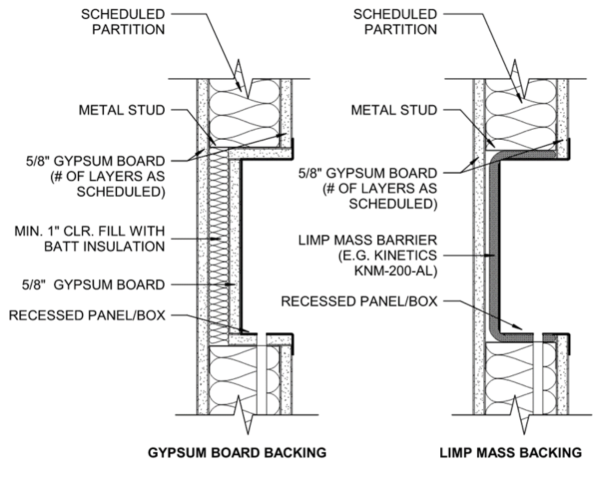
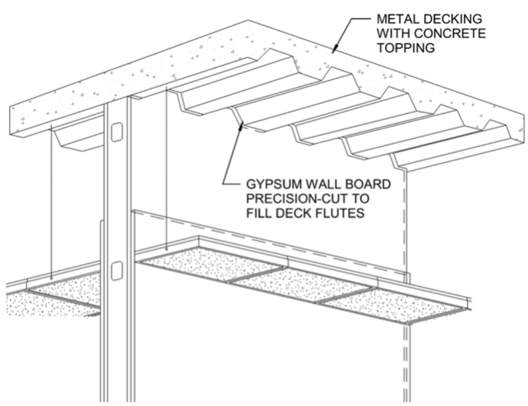


Figure 5.10.2.14 Partition Termination Parallel to Metal Deck



NOTES:
1) LIMP MASS BARRIER AVAILABLE FROM ACOUSTHETICS (415) 753-1301

Figure 5.10.2.16 Recessed Panels and Fixtures



NOTE:
1) IF AN ACOUSTICAL TILE CEILING IS LOCATED ON BOTH SIDES OF THE PARTITION, HILTI SPEED PLUGS OR SIMILAR CAN BE USED TO PLUG THE DECK FLUTES IN LIEU OF PRECISION CUTTING THE TOP OF THE GYPSUM BOARD.

Figure 5.10.2.15 Partition Termination Perpendicular to Metal Deck

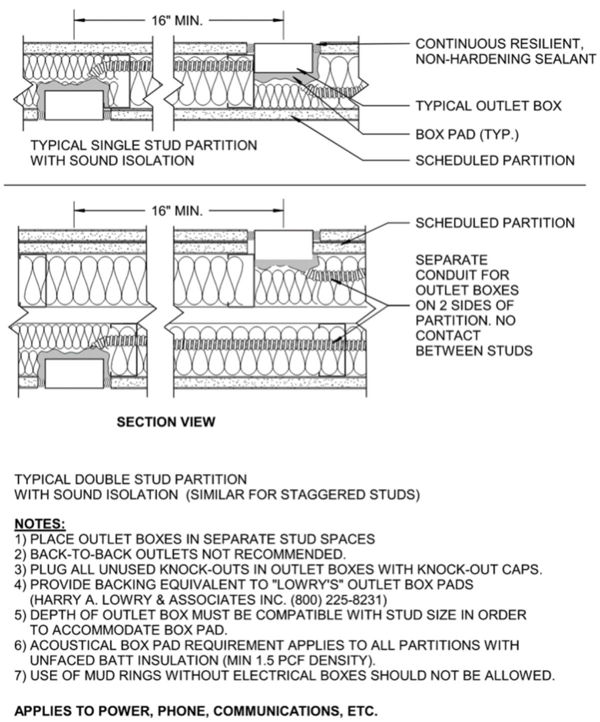


Figure 5.10.2.17 Junction Box Isolation

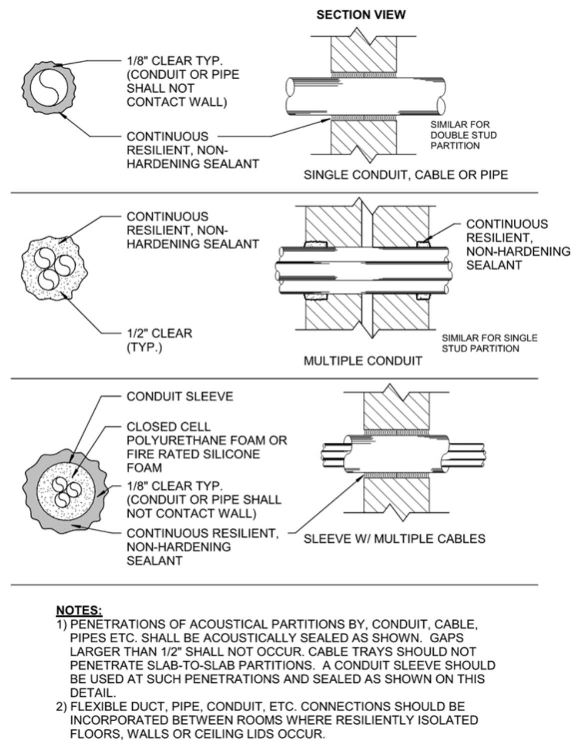


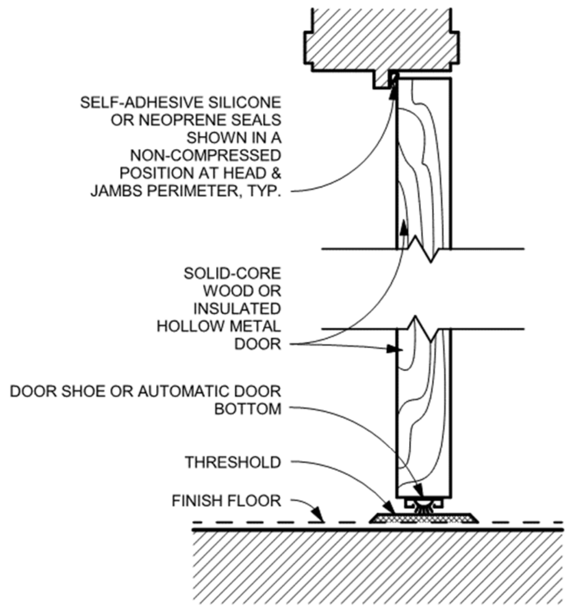
Figure 5.10.2.18 Partition Penetration Details

5.10.2.3 DOORS

Doors between adjacent sound sensitive spaces (such as classroom to classroom or conference room to conference room) should be avoided, otherwise STC rated sound control door assemblies equal to the STC demising wall rating listed in the criteria section will be required to maintain sound isolation.

Entry doors to occupied spaces should be solid core wood or insulated hollow metal with a minimum surface density of 5 psf. Entry doors to core learning spaces as well as conference rooms (and other rooms where speech privacy is a concern) and MEP / IT / Elevator Machine Rooms (or any other noise emitting rooms) should incorporate rubber bulb gasketing and automatic door bottoms. These doors should provide STC 30 (NIC 28) minimum sound isolation performance. Door undercuts shall be no more than 1/4". A typical entry door with automatic door bottom is shown below.

Doors to noise emitting rooms such as MEP / IT / Elevator Machine Room should not open into acoustically sensitive spaces, otherwise STC rated sound control door will be required.



				AUTOMATIC DOOR BOTTOM	
MANUFACTURER	PERIMETER	ASTRAGAL	SHOE	MORTISE	SURFACE MOUNT
PEMKO	S-88	355CS	234	434A/420A	
NATIONAL GUARD	5050	109N		423N	420N
REESE	797		DB591F	371	521
ULTRA				DB 043	
ZERO		1840	253A	369	367

Figure 5.10.2.19 Doors to Core Learning Spaces and Other Noise-Sensitive Spaces

5.10.2.4 INTERIOR GLAZING

Glazing located at office/conference room fronts or at Core Learning Spaces can be an acoustical "weak link." Vision windows between adjacent sound sensitive spaces (such as classroom to classroom or conference room to conference room) should be avoided, otherwise STC rated sound control window assemblies equal to the STC demising wall rating listed in the criteria section will be required to maintain sound isolation. When glazing is located adjacent to a door (e.g., a sidelite), 1/2" thick glazing is sufficient. However, if glazing is located in a partition without a door or a wall is fully glazed, then a more robust glazing system (e.g., dual pane with 2" airspace) will be necessary.

5.10.2.5 OPERABLE PARTITIONS

If operable partitions are added, close coordination with the operable partition design is important to verify that the perimeter conditions (e.g., head, base, sides) of the operable partition do not compromise the sound isolation performance of the operable partition. Generally, an operable partition should have an STC rating equal to or higher than that of a standard framed wall. For most adjacencies, an operable partition should have a STC rating of 50 and NIC rating of 42. The STC rating listed by operable partition manufacturers should be for the assembly, and not only the panel.

Depending on its location, it may be recommended that the facing of the operable partition incorporate acoustically absorptive materials to reduce reverberation in the space.

5.10.2.6 FLOOR-CEILING ASSEMBLY SOUND ISOLATION

While the structural system is not known, where hard-surface floors are planned, an acoustical underlayment will be necessary. The thickness and type of underlayment is as follows:

- Carpet tile: no underlayment required
- Vinyl: 2mm thick Pliteq RST, Ecore, or Acousticork or cushioned vinyl should be used. If a third-party underlayment is used, the flooring manufacturer needs to review the assembly. See figure below:

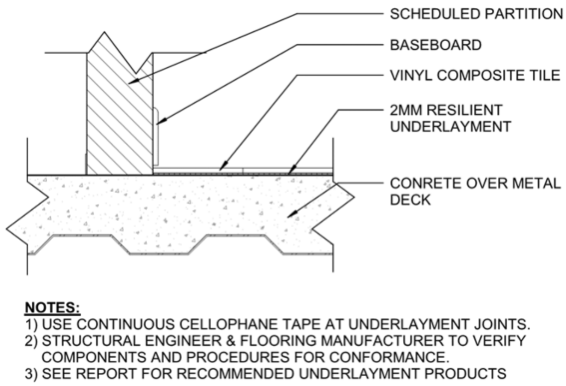


Figure 5.10.2.20 Floor Assembly with Vinyl Flooring and Underlayment

- Hardwood or Tile: 5mm thick Pliteq RST, Ecore, or Acousticork
- Polished Concrete: Will require a topping slab with underlayment if there is no suspended ceiling below (see figure below)

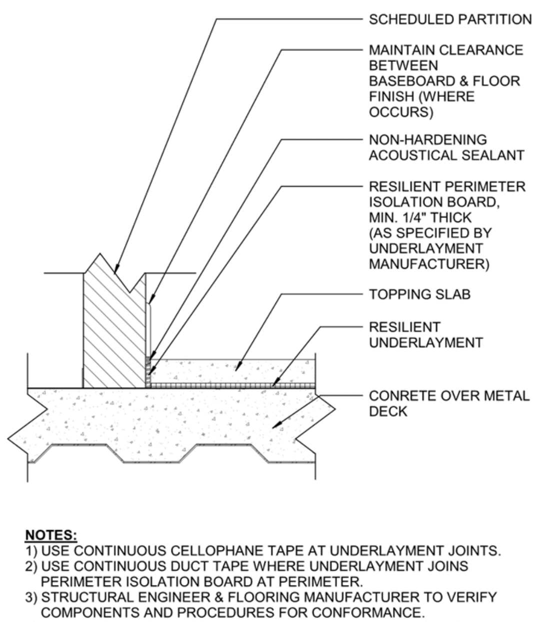


Figure 5.10.2.21 Floor Assembly with Topping Slab (for Polished Concrete)

To meet the STC 50 criterion between core learning spaces, either a 6" concrete or composite metal-concrete deck with a total thickness of at least 5-1/2" inches (measured from bottom of flute to top of concrete) is necessary.

5.10.2.7 STAIRS

Stairs should be supported at the landings and stringers should not be connected to the wall shared with a learning space, conference room, or other noise-sensitive space. Stair treads and landings should be concrete-filled.

5.10.2.8 LABORATORY TOOLS - VIBRATION

Equipment and instruments that are extremely sensitive to vibration should be identified during the early stages of design and located on slab-on-grade to minimize the transient structure-borne vibration. Provisions of an isolated slab should be considered. Pneumatic and piezoelectric isolations should be used, as required, on specified highly sensitive equipment. Installation and vibration requirements from the tool / instrument manufacturer must be met.

5.10.2.9 EXTERIOR SOUND ISOLATION

The project shall comply with the acoustical requirements of the California Green Building code for environmental noise. In order to reduce distractions and allow for a more conducive learning environment, more stringent criteria are provided for specific rooms within the building in the criteria table above. The acoustical impact of environmental and all new and existing outdoor equipment (mechanical and electrical) noise on interior noise levels within rooms that may be impacted by the exterior noise should be quantified. Acoustical recommendations in the form of the equipment selections, building facade recommendations, noise control recommendations for the new and existing equipment should be provided so that exterior noise intrusion from all sources is limited to the values in the criteria table. Exterior windows must have an STC rating of at least 35, unless outdoor and indoor noise levels can be verified to justify a lower rating.

5.10.2.10 ROOM ACOUSTICS

To achieve the reverberation time criteria, acoustically absorptive finish materials are required. Typically, this is accomplished by specifying a sound absorbing ceiling (e.g., a suspended acoustical tile ceiling). Where a suspended acoustical tile ceiling is not planned, surface applied wall panels or ceiling panels can be specified (e.g., Autex, Kirei, Euromat). The minimum NRC rating of the selected acoustically absorptive material should be NRC 0.75 and most spaces require approximately 70 to 80% of the room's ceiling area (in terms of square feet) in absorptive materials to achieve the criteria. The acoustic ceiling tile products (e.g., Armstrong Ultima High NRC, Certainteed Performa, Armstrong Optima, USG Mars) can meet NRC 0.75.

If hard-surfaced flooring is planned at classrooms or other spaces (e.g., concrete, vinyl), then acoustically absorptive wall panels at 20% to 30% of the wall area will likely be needed (depending on total room volume and the space criteria). Reverberation time calculations should be performed when floor finish selections are made.

You may consider the addition of acoustically absorptive materials in corridors and circulation spaces to reduce noise build-up and disruption to adjacent classes/spaces. The necessity for this is dependent on whether there will be large numbers of people utilizing the corridors while class is in session. This can also be considered as a "Day 2" (post-construction) option. For budgeting purposes, assume that the required number of square feet is equal to the floor area (absorptive materials can be placed on the ceiling or upper wall areas).

Where it is important to utilize acoustically absorptive materials that can be easily cleaned, product options include Conwed Metro Rebound, Decoustics High Impact Resistant, Kinetics High Impact Hardside (PVC face).

5.10.2.11 MECHANICAL / HVAC NOISE AND VIBRATION

Note: These guidelines should be considered general in nature and it may be necessary to modify these guidelines to meet fire, structural, and/or other project requirements.

- Where possible, ducts should be sized to limit maximum air velocities as indicated in Table 2 below, to ensure that regenerated noise due to air movement does not cause the relevant design noise criteria to be exceeded.

Location	Noise Criterion - NC				
	45	40	35	30	25
Riser - rectangular duct	2500	2250	2000	1750	-
Main branch above suspended ceiling - rectangular duct	2500	1800	1550	1300	-
Exposed duct in occupied areas - rectangular duct	2000	1700	1450	1150	-
Duct within 10 to 20 feet of supply diffuser (S) / return grille (R)	900(S)/ 1000(R)	850(S)/ 950(R)	800(S) /900(R)	700(S) /800(R)	550(S) / 650(R)
Duct within 0 to 10 feet of supply diffuser (S)/return grille (R)	700(S)/ 800(R)	650(S)/ 750(R)	600(S) / 700(R)	500(S) / 600(R)	450(S) / 500(R)
Supply Diffuser - 'free' velocity	550	500	450	400	300
Return Grille - 'free' velocity	650	600	550	500	400
Open return duct above ceiling	850	750	650	-	-

Note: These velocity guidelines assume good airflow conditions. Presence of elbows, fittings, or abrupt duct transitions may require air to run at lower velocities.

Table 5.10.2 Design Guidelines for Maximum Air Velocities in Ducts in Feet Per Minute (FPM)

- Supply air diffusers and return air grilles should be selected with manufacturer's noise rating 5 NC points below the HVAC design noise criterion of the area served. Where possible, connections to diffusers should utilize lined flex-duct to reduce any noise generated by flow through individual take-offs.
- Where possible, flex-duct should consist of a flexible vapor barrier jacket with a wire reinforced inner core containing 1 1/2-inch thick resilient glass fiber insulation faced with reinforced coasted glass fabric; conforming to NFPA Standard 90A. Regenerative noise due to air turbulence within the duct shall not exceed the following sound power levels for a 12-inch diameter duct with an air speed of 1,000 FPM.

	Sound Power Levels, dB re: 10-12 Watts, at each octave band center frequency, Hz				
	125	250	500	1k	2k
Max. Regenerative Noise, dB	30	31	30	22	20

- Acoustically acceptable flex-duct products include:
  - a. Genflex IL
  - b. Casco Silentflex
  - c. Cody West type NILS
  - d. Flexmaster Acoustical Flex
  - e. Casco Acoustical Flex Duct (SF-181M)
  - f. Thermaflex Acoustical Flexible Air Duct
- The need for duct silencers (sound traps) and internal duct lining should be evaluated as the design progresses. A sufficient length of ductwork should occur between the AC unit and the silencer. Typically, there should be at least one and preferably two duct "diagonal(s)" of straight duct at either end of the attenuator prior to connections to equipment or fittings such as elbows. Silencers should be sized for a maximum pressure drop of 0.25 inches w.g.
- Fan coil units should not be located above any space with noise criteria of NC 30 or lower. Otherwise, a solid gypsum board ceiling or enclosure will be needed.
- Supply and return ductwork for the fan coil units should be internally lined with 1" duct lining. There should be 5 feet of acoustical flex duct at diffusers and grilles.
- Ducted indoor VRF or mini-split system should be designed to 0.5" or less static pressure.
- Where possible, volume control boxes should not be located within the acoustically sensitive rooms, and in general should be selected with a manufacturer's noise rating 10 NC points below that of the room served and the room over which the box is located for both discharge and radiated noise.
- A combination of acoustically lined ductwork and standard flexible duct will typically be required downstream of the VAV box to control discharge noise. If this cannot be accommodated, boxes may need to be oversized to reduce the overall noise levels generated.
- As far as is practical, HVAC systems serving acoustically sensitive occupied areas should be "self-bal-

ancing." Balancing dampers should not be located immediately upstream of diffusers. There should be a minimum of 5 feet of acoustical flexible duct or internally lined sheet metal duct between the damper and the connection to the diffuser. Dampers should not be incorporated into grilles, and diffuser blades should not be used for balancing of the air system.

- Recommendations for crosstalk control between occupied spaces should be provided as the design develops. It is acoustically preferred that return air systems be fully ducted where crosstalk is a concern. If this is not the case, crosstalk control may be required at air transfer openings.
- At open returns (i.e., where the return grille opens to the ceiling plenum) in enclosed, noise-sensitive rooms, duct boots should be used to reduce cross-talk. The duct boot opening should be pointed in the opposite direction from the entry door and not connected to the transfer grille; see image below.

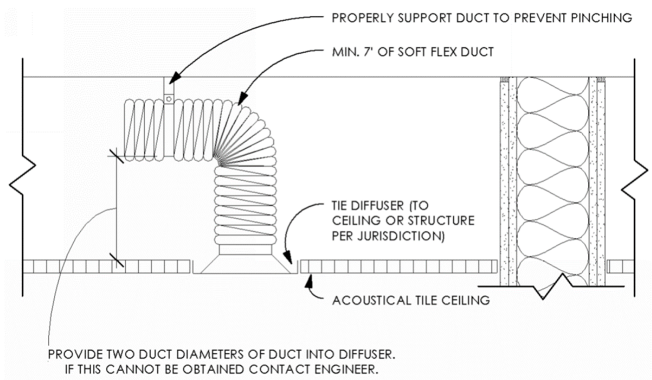


Figure 5.10.2.22 Duct Boot at Plenum Returns

- Return air transfer grilles at enclosed, noise-sensitive spaces (i.e., conference rooms, meeting rooms, and spaces with automatic door bottoms) should incorporate a transfer grille silencer, such as the Commercial Acoustics TS-4 or Ruskin GSV4 or use a lined transfer elbow (see image below). Transfer grilles should be located above doors and not located in sound-rated partitions (e.g., partitions separating adjacent classrooms, conference rooms, etc.) without doors.

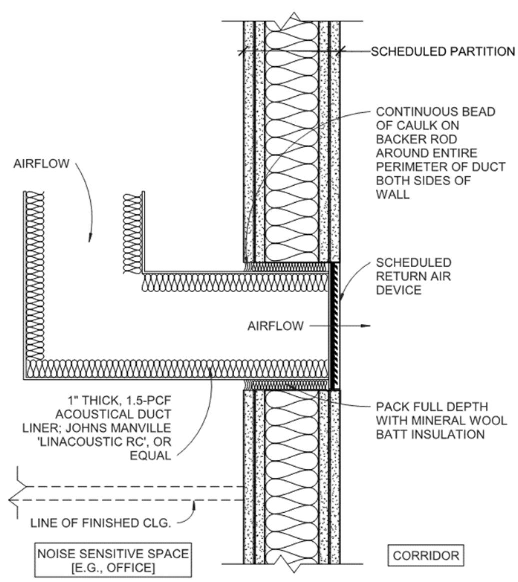


Figure 5.10.2.23 Return Air Transfer Duct Grille

- The following vibration isolation recommendations are based on ASHRAE guidelines.

  1. All spring mounts should be unhoused and incorporate a neoprene pad or cup. We recommend that floor-mounted springs be Mason Type SLFH or equal; where necessary, Mason Z-1225 seismic snubbers or restrained springs equal to Mason Type SLR should be used.
  2. Spring hangers should have a spring in series with neoprene and must allow for up to 30 degrees of misalignment; spring hangers should be Mason 30N or equal. Where equipment requires springs and is mounted on a roof curb, the roof curb should include integral springs (e.g., Mason RSC).
  3. Double deflection neoprene should have a molded unit type neoprene element with a projecting bushing lining rode clearance hole. The neoprene element should be a minimum 1 3/4 inch (45 mm) thick with a steel retaining box encasing the neoprene mounting; neoprene should be Mason HD or equal.
  4. Neoprene waffle pad should have a ribbed or waffled design, with a minimum thickness of 0.75-inch (19 mm). Pads should be selected for adequate durometer to handle loads and reduce over compression. We recommend that pads be Mason Super W or equal.
  5. All connections to vibration isolated equipment should be flexible; this includes electrical service, plumbing/piping, and duct. Where possible, service loops should be provided. Duct connections should be canvas style, high pressure fluid lines should be twin sphere (e.g., Mason SFDEJ) or steel braided with a minimum length of 12 inches. Generator flue exhaust should utilize an open pitch style steel braided hose with a length equal to four (4) times the diameter, with a minimum length of 12 inches and a maximum length of 24 inches.
  6. Suspended piping and pipe risers will be resiliently isolated from the building structure.
  7. Table 3 provides vibration isolation guidelines for various types of mechanical equipment; the structural engineer should confirm that the deflection of the support structure due to the weight of the mechanical equipment is no more than 8-10% of the specified vibration isolator deflection.

(On grade and above-grade installations with spans < 20ft and speeds > 500 RPM)		
Equipment Type	**Isolator Type**	**Static Deflection (inches)**
Fans (including AHU, ERU, RTU)	Spring & Neoprene	2
Horizontal Fan Coil Units / Heat Pumps	Spring & Neoprene	1
Vertical Fan Coil Units	Neoprene	0.3
Cooling Towers (above NC 40 spaces)	Spring & Neoprene	2
Cooling Towers (above residential or < NC 35 spaces)	Spring & Neoprene	3
Dry coolers, Air-Cooled Condenser, Air-Cooled Chillers, Air-Cooled Equipment	Spring & Neoprene	2
Mechanical & Domestic Pumps ≥ 5hp (Base-Mounted)	Spring & Neoprene	2
Mechanical & Domestic Pumps less than 5hp	Double-deflection Neoprene	0.3
Condensate Pumps	Neoprene Waffle Pad	0.1
Heat Exchangers	Spring & Neoprene	1
Boilers	Neoprene	0.3
Hot Water Generators, Boilers (Skid Mounted)	Spring & Neoprene	1
Air Compressors	Spring & Neoprene	1
Generators	Spring & Neoprene	2
Transformers < 150 kVA	Double-deflection Neoprene	0.3
Transformers ≥ 150 kVA	Spring & Neoprene	1

Table 5.10.3 Vibration Isolation Guidelines

- Do not penetrate sound-rated partitions with flex duct.
- Where possible, rooftop units should not be located above acoustically sensitive spaces.
- Ducts should be properly sealed to avoid leaks which generate duct whistling/airflow noise.
- Exhaust fans should be isolated with springs.
- Screen all rooftop and ground mounted equipment from street views. Locate equipment to avoid increased noise levels within building.
-

5.10.2.12 PLUMBING NOISE AND VIBRATION

- Plumbing should not be routed through partitions at rooms designated as NC 30 or below. For NC 30 to 45 rooms, if piping is located above an acoustical (mineral tile) ceiling, piping should be wrapped within mass-loaded vinyl or acoustical equivalent with a minimum surface weight of 2.0 psf over 1” thick fiberglass insulation.

- To reduce water-flow noise at sensitive spaces, all supply, hot-water heating, waste, HVAC, and drain piping must be vibration isolated when located adjacent to sensitive spaces.
    1. For pipes one inch diameter or less, Acousto-Plumb or Hubbard Holdrite Silencer clamps should be used.
    2. For waste pipes and supply pipes greater than one-inch diameter, isolate riser clamps with neoprene waffle pads and/or utilize the Armaflex or Trisolator isolators.

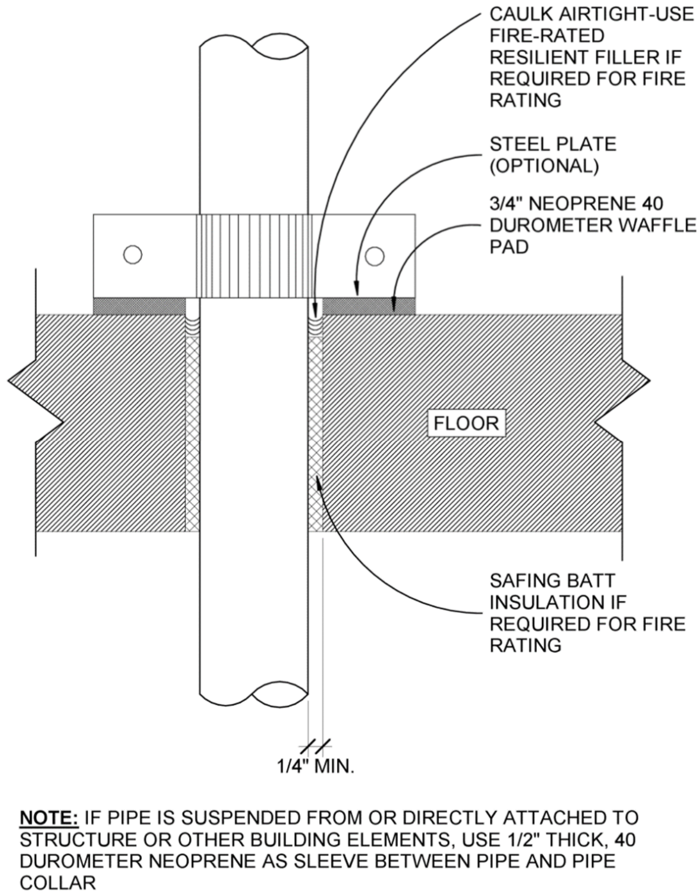


Figure 5.10.2.24 Plumbing Riser Isolation

3. For trapeze piping supports, utilize combination neoprene/spring isolators at trapeze or other pipe hangers for the first three points of support or 50 feet (whichever is greater) after a pump or other vibration isolated equipment if the connection to the equipment is not flexible. See image below. For pipes greater than five-inches in diameter, flexible connections should be used at the outlet of the pump or other vibration-generating equipment.

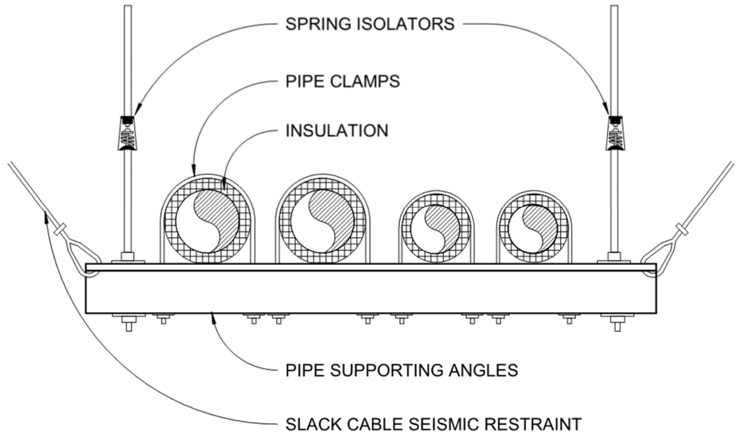


Figure 5.10.2.25 Trapeze Piping Acoustic Isolation

4. Do not allow piping, pipe connectors, pipe hangers, or valves to directly touch the structure, studs, gypsum board, or other pipes.
5. Support pipe as required by Uniform Plumbing Code.
6. Plumbing penetrations should be sealed airtight with acoustical sealant.

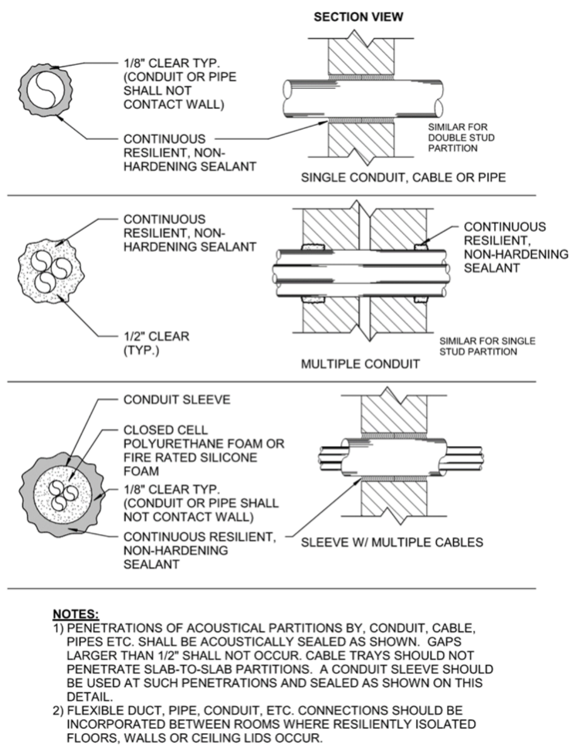


Figure 5.10.2.26 Partition Penetration Details

7. Cast iron waste pipe is recommended; if ABS or other lightweight/thin wall material is planned, then pipe must be wrapped with Lowry's pipe wrap.
8. Horizontal, cast-iron sanitary waste pipes above noise-sensitive spaces (e.g., bedrooms, living rooms) should be wrapped with pipe wrap such as Lowry's pipe wrap.

- Size supply piping for a maximum water-flow rate as shown in Table 4.

Pipe Diameter (in.)	Maximum Water Flow Velocity (fps)	Maximum flow rate (gpm)
1/2	4	3
3/4	4	6
1	4	10
1-1/4	4	15
1-1/2	4	25
2	4	42
2-1/2	5	74
3	6	138
4	7	277
6	8	720

Table 5.10.4 Maximum Plumbing Flow Rates

- Plumbing walls should be sized to permit installation of piping, clamps and brackets without contact with studs or wallboard. Do not locate supply or wastewater pipes closer than one inch from gypsum board in walls or ceilings of sensitive spaces (e.g., conference rooms, etc.). All stud bays containing plumbing piping adjacent to sensitive spaces should contain batt insulation.

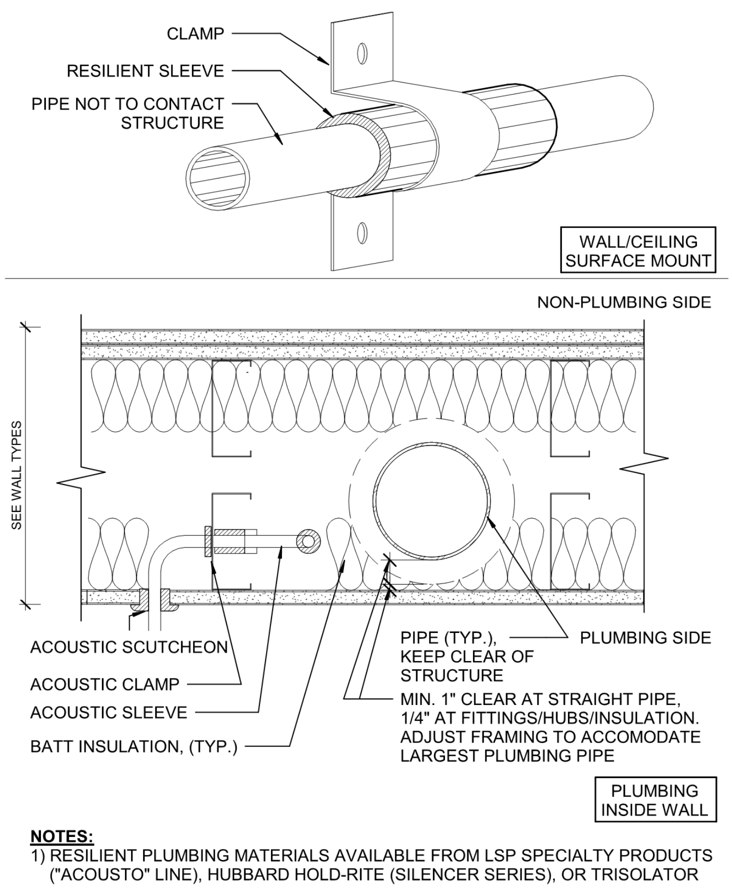
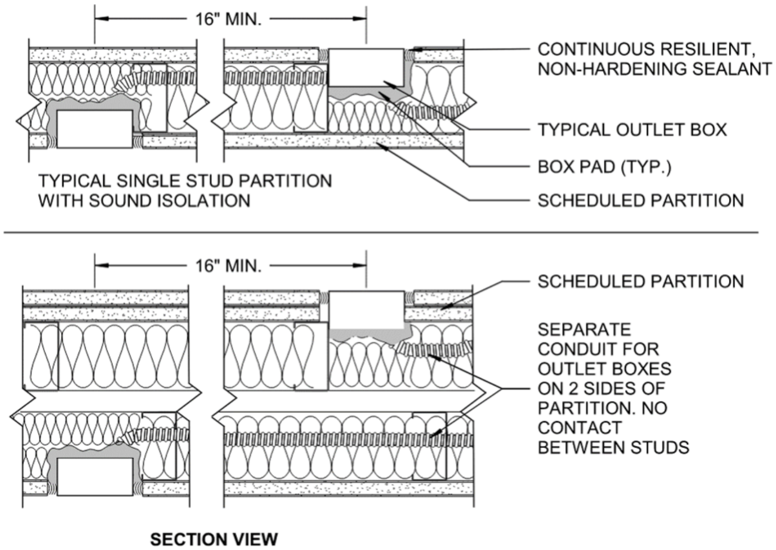


Figure 5.10.2.27 Plumbing Isolation at Noise-Sensitive Spaces

- Walls at sensitive spaces containing plumbing should have batt insulation in the stud or joist cavity containing the piping.
- Piping, clamps, or brackets must not bridge stud rows in double-stud walls.
- Holes cut in plates should be big enough to allow 1/2-inch clearance around pipe. It may be necessary to use a 6-inch, rather than 4-inch, plate to achieve this.
- Avoid placing rainwater leaders in sound-rated partitions at sensitive spaces.
- Stormwater and waste pipes should not be routed over or through noise-sensitive spaces and should be cast iron.
- Base-mounted pumps should be isolated with springs having a two-inch static deflection; inline pumps should be isolated with springs having one-inch static deflection.

5.10.2.13 ELECTRICAL NOISE AND VIBRATION

- Isolate all transformers as shown in Table 3. Transformers should be floor mounted.
- Transformers should not be mounted on framed walls that are adjacent to sensitive spaces.
- Place inverters at least 2 feet from any gypsum board framed wall (if associated with public/sensitive space) and vibration isolate similar as the transformers.
- Electrical connections to HVAC units, motors or other rotating equipment should be made with flexible conduit.
- In double-stud partitions, conduit should not bridge stud rows. Conduit should be routed only in the studs on the side of the unit served and should not be placed in the gap between stud rows.
- Outlet boxes on opposite sides of sound-rated partitions should be separated by at least 16 inches and provide backing equivalent to Lowry's outlet box pads. See image below. Ring-and-string for low voltage cabling is not allowed in sound-rated partitions. A traditional junction box should be used.



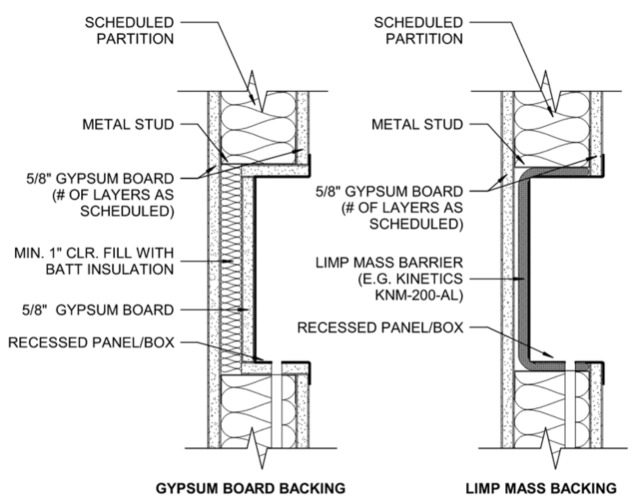
TYPICAL DOUBLE STUD PARTITION
WITH SOUND ISOLATION (SIMILAR FOR STAGGERED STUDS)

NOTES:
1) PLACE OUTLET BOXES IN SEPARATE STUD SPACES
2) BACK-TO-BACK OUTLETS NOT RECOMMENDED.
3) PLUG ALL UNUSED KNOCK-OUTS IN OUTLET BOXES WITH KNOCK-OUT CAPS.
4) PROVIDE BACKING EQUIVALENT TO "LOWRY'S" OUTLET BOX PADS (HARRY A. LOWRY & ASSOCIATES INC. (800) 225-8231)
5) DEPTH OF OUTLET BOX MUST BE COMPATIBLE WITH STUD SIZE IN ORDER TO ACCOMMODATE BOX PAD.
6) ACOUSTICAL BOX PAD REQUIREMENT APPLIES TO ALL PARTITIONS WITH UNFACED BATT INSULATION (MIN 1.5 PCF DENSITY).
7) USE OF MUD RINGS WITHOUT ELECTRICAL BOXES SHOULD NOT BE ALLOWED.

APPLIES TO POWER, PHONE, COMMUNICATIONS, ETC.

Figure 5.10.2.28 Junction Box Treatment

- Recessed panels, etc. should be treated as shown in image below.



NOTES:
1) LIMP MASS BARRIER AVAILABLE FROM ACOUSTHETICS (415) 753-1301

Figure 5.10.2.29 Recessed Panels and Fixtures

- Do not allow electrical conduit or boxes to come into contact with plumbing.
- Cable tray and conduit penetrations in partitions should be packed tightly with heavy density putty once the cables are pulled.

5.10.2.14 ELEVATOR NOISE AND VIBRATION

Elevator machine rooms shall not be located adjacent to rooms with an NC criterion of 40 or lower. If this cannot be avoided, elevator machine rooms should be located on grade level and STC 60 minimum walls and floor/ceiling assemblies shall be constructed around the rooms so that elevator machine room noise is not audible in adjacent rooms with an NC 35 or lower background noise level criterion. If the elevator machine room cannot be located on grade and is located above a room with an NC 40 or lower background noise criterion, the elevator machine room should be equipped with a 4-inch thick concrete floating floor to provide airborne sound isolation to the noise sensitive room below. The concrete floating floor should consist of 4-inch normal weight concrete supported by neoprene mounts with a 2-inch minimum airspace between the structural slab and floated concrete slab.

The power unit (motor/pump/tank) shall be vibration isolated from the building structure via seismically restrained neoprene mounts (e.g., Mason BR) that provide 0.35-inch minimum static deflection under the operational load of the power unit.

Isolate hydraulic pipes from the building structure via neoprene lined clamps from the tank to the piston base. Hydraulic pipes shall be isolated from walls and floors at penetrations via foam neoprene pipe insulation. Pipe should not come in rigid contact with the building structure. Provide an oil line muffler in the oil line near the pump. Provide Isolation Couplings in the oil line near the pump unit and near the jack unit. Electrical conduit and raceway connections made to the power unit shall be resiliently mounted to building structure via neoprene pads or mounts so as to not transmit airborne or structure-borne noise to adjacent spaces.

5.10.3 APPENDIX A: DEFINITION OF TERMS

ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; Chapter 49. Noise and Vibration Control.

Ceiling Attenuation Class (CAC): CAC rates a ceiling panel's noise reduction performance; higher values correspond to increased noise reduction.

Impact Insulation Class (IIC): A single-number laboratory rating which quantifies the property of a floor/ ceiling construction to reduce footfall-generated noise. Increasing IIC values correspond to improved impact insulation.

Noise Criteria (NC): Noise Criteria ratings approximate the human perception of "noisiness" within buildings. The NC rating is based on 8 octave band sound pressure level measurements in which building machinery normally produce sound which can be annoying to the occupants. These eight measurements are compared with a family of curves. The highest curve under which all the data fall is the rating. This rating is not applicable to pure tones where a penalty must be added since they are perceived to be more "noisy." High NC ratings are louder and an increase by 10 points approximates a doubling of perceived loudness.

Noise Reduction Coefficient (NRC): A measure of the acoustical absorption performance of a material, calculated by averaging its sound absorption coefficients at 250, 500, 1000 and 2000 Hz, expressed to the nearest integral multiple of 0.05.

Reverberation Time (RT60): The time it takes for sound to decay 60 dB in a room. Large rooms with hard surfaces, such as concert halls, have reverberation times around 2 seconds. Smaller rooms with sound absorbing surfaces have shorter reverberation times. Music sounds richer in rooms with long reverberation times, but speech may be difficult to understand. Speech is more intelligible in rooms with shorter reverberation times, but music may sound dry.

Mid-frequency Reverberation Time (Tmf): The average reverberation times in the 500 Hz, 1 kHz and 2 kHz octave bands; it is an appropriate metric for speech communication.

Sound Transmission Class (STC): A single-figure laboratory rating used to compare walls, floor-ceiling assemblies and doors for their sound insulating properties with respect to reducing airborne noise.

A-Weighted Sound Level: A term for the A-Weighted sound pressure level. The sound level is obtained by use of a standard sound level meter and is expressed in decibels. Sometimes the unit of sound level is written as dB(A).

L_{eq}: The time-weighted average noise level during the stated measurement period.

5.10.4 APPENDIX B: REFERENCE STANDARDS

2019 California Green Building Code - The CalGreen building code places limits on interior noise levels of non-residential buildings due to exterior noise that exceeds an hourly A-weighted level of 65 dBA during any hour of operation. If a noise sensitive space requires a lower background noise level than 50 dBA, then additional facade noise control measures shall be taken to achieve the required interior noise levels.

California State University (CSU) Guidelines and Standards. There are no binding acoustical criteria in these standards.

ASTM C 423 "Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method"

ASTM E 90 "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements"

ASTM E 336 "Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings"

ASTM E 413 "Classification for Rating Sound Insulation"

ASTM E1007 "Test Method for Field Measurement of Tapping Machine Impact"

ANSI Standard S12.60-2010 – Performance Criteria, Design Requirements and Guidelines for Schools, Part 1: Permanent Schools.

LEED v4.1 for New Construction – Indoor Environmental Quality Credit: Acoustic Performance

ASHRAE (2019) – Chapter 49 Noise and Vibration Control

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06
CODE ANALYSIS

6.1 PRELIMINARY BUILDING CODE ANALYSIS

The following preliminary code analysis is based on the California Code of Regulations, Title 24, Part 2 - the 2019 California Building Code (CBC). During Schematic Design, a comprehensive code analysis will be developed. The following analysis may vary with subsequent editions of the building code. Code edition is determined at the time of submittal of construction plans. This review is based on the 2022 code, with the new code cycle taking effect January 1, 2023.

Type of Construction is a choice by the designer/owner. Type II-B construction has been used here in consultation with the AOR as the best feasible choice for meeting program requirements.

Building Description:	The building is two stories tall and approximately 22,000 GSF total. The occupied floors are composed predominately of teaching labs, offices and research labs. The building contains primarily B Occupancies with some A-3 and a small amount of S-2.
Building Code:	2022 California Building Code
Building Area:	Approximately 22,000 GSF
Occupancy:	Mixed A-3 and B with minor S-2
Construction Type:	Type II-B
Allowable Area: (Table 506.2)	69,000 max/per floor for B as most restrictive occupancy w/AFSS 28,500 max/per floor for A-3 if most restrictive occupancy w/AFSS Proposed – No floor is expected to exceed the 28,500 square feet. Treat building as most restrictive
Maximum Number of Stories: (Table 504.4)	Allowed – A3 at 3 stories B at 4 stories Proposed - 2 stories
Maximum Building Height: (Table 504.3)	Allowable B = 55 feet, Allowable A - 75 feet Proposed - 34’ (Level 1 = 0’; Level 2 = 18’; Roof = 34’)
High-Rise Classification: Highest Occupied Floor: (Section 403)	Non high-rise Allowed - 75' Proposed - 18' (Level 2)

Chemical Quantities and Control Areas: (Section 307.1(1))	The Maximum Allowable Quantities (MAQ's) of hazardous materials will be in accordance with the CBC and CFC for indoor control areas. The number of control areas per floor will be determined in Schematic Design following an analysis of the chemicals used.
Fire Sprinkler System:	The building is required to be provided with automatic fire sprinklers (AFSS) throughout the building. There is a consideration that certain high priced electrical equipment may be at risk of accidental sprinkler activation or system leaks from piping onto the electrical equipment; causing shorts and possible life risk. The primary concern is in the Grid Simulation Lab and Grid Sim Data Center. The recommendation for is to utilize a double-interlock pre-action AFSS in both spaces. A clean agent system may be considered in the Data Center to provide for a faster fire suppression response to reduce the negative impact of business interruption and/or the sensitivity of the data stored, but is not being considered here for the purposes of this Feasibility Study. A pre-action AFSS allows for the sprinkler piping in the space to be pressured with air or nitrogen and holds the water at the riser outside of the space.
Occupancy Separation:	Given the maximum proposed area is not expected to exceed the Allowable Area per A-3 requirements, no separation is required between occupancies per CBC 508.3.3.
Elevator Lobby:	Not required per CBC Section 3006.3-5. The elevators are not being used as a means of egress.
Convenience Stair:	With the siting of the building on a sloped site, it is not expected the interior open stair will be required to perform as part of the building's interior means of egress.
Outdoor Terrace	The Terrace will most likely be used for public assembly (gathering of people) for different types of assembly. The area of this space must be included with the total area as an occupied roof. Egress will require a minimum of two exits/stairs. Further study is required if the egress from the assembly space can go through the rooftop solar lab.

Mass Notification	CFC 917 notes that a mass notification risk analysis be conducted prior to construction of buildings with an occupant load of 1,000 or more. The anticipated occupant load of this building should not exceed 1,000 occupants, however other planned project on this campus probably will exceed this number, thus a risk analysis may be required. The risk analysis should be campus wide. If it is required for other buildings, the University may opt to include in for this project also. University should be made aware of this requirement.
High Fire Severity Zones	CalFire online maps for location of High Fire Severity Zones were reviewed as part of this analysis. It appears that the campus is within a Local Responsibility Area High or Moderate severity zone, thus CBC Wildland Urban Interface (WUI) requirements may apply. This should be verified with the Arcata Fire Department.
ERRCS	Emergency Responder Radio Coverage (ERRCS) is required, however depending on the construction, a system may or not be needed. We recommend that the infrastructure for a system be planned for and testing conducted upon completion of the major elements of construction.

Fire-Resistance Rating	Primary Structural Frame	0-hrs
for Building Elements:	Bearing Walls Exterior	0-hrs
(per Table 601)	Bearing Walls Interior	0-hrs
	Non-bearing walls/partitions Interior	**
	Non-bearing walls/partitions Interior	0-hr
	Floor construction	0-hrs
	Roof Construction	0-hr

** This will need to be reviewed against the final design

6.2 APPLICABLE CODES AND STANDARDS

Applicable State Codes (latest edition)

- Title 24, Part 1 - California Building Standards Administrative Code
- Title 24, Part 2 - California Building Code (CBC)
- Title 24, Part 3 - California Electrical Code (CEC)
- Title 24, Part 4 - California Mechanical Code (CMC)
- Title 24, Part 5 - California Plumbing Code (CPC)
- Title 24, Part 6 - California Energy Code (Title 24)
- Title 24, Part 9 - California Fire Code (CFC)
- Title 24, Part 11 - California Green Building Standards Code (CALGreen)
- Title 24, Part 12 - California Referenced Standards Code
- California Code of Regulations; Title 8, Title 19

Applicable National Codes (latest adopted edition)

- ADA - Americans with Disabilities Act Accessibility Guidelines
- IESI - Illuminating Engineering Society of North America
- NEMA - National Electrical Manufacturers Association
- National Fire Protection Association (NFPA) Guidelines and Standards

Guidelines and Standards (latest adopted edition)

- ACGIH Industrial Ventilation - A Manual of Recommended Practice
- ANSI Z358.1 Emergency Eyewash and Shower Equipment
- ANSI/AIHA Z9.5 - Laboratory Ventilation Standard
- ASHRAE Standard 62.1 Ventilation for Acceptable Indoor Air Quality
- ASHRAE Standard 110 - Method of Testing Performance of Laboratory Fume Hoods
- LEED (Leadership in Energy and Environmental Design)
- OSHA (Occupational Safety and Health Administration Standard) 29 CFR 1926 and 29 CFR 1910
- Applicable National Codes: IEEE C2: National Electrical Safety Code (2007)
- Guidelines and Standards: IEEE Institute of Electrical and Electronics Engineers

07

APPENDIX

7.1 INITIAL DISTRIBUTED RENEWABLE ENERGY AND MICROGRID LABORATORY NARRATIVE

July 15, 2021

Distributed Renewable Energy and Microgrid Laboratory
Schatz Energy Research Center

In this year's state budget, there is support to build a state-of-the-art **Distributed Renewable Energy and Microgrid Laboratory,** to be located adjacent to the Schatz Energy Research Center on the HSU campus**.**

Background

California's energy system is undergoing a dramatic transition as the state works to meet the climate and clean energy goals specified in Senate Bill 100, including a target of 100% clean energy by 2045. Simultaneously, the state needs to increase the resilience of its energy system as it adapts to extreme weather and wildfire events associated with global warming. To meet these goals, California needs:

- A skilled workforce that is ready to rapidly ramp up clean and resilient energy systems over the coming decades
- A state-of-the-art laboratory equipped to develop and test the technologies and designs necessary to install microgrids throughout the state

Vision for the Facility

The **Distributed Renewable Energy and Microgrid Laboratory** will support our students to become the next generation of energy professionals. It will enable deep engagement with cutting-edge, clean energy technology to understand how it works, run lab experiments, and invent and test new ideas. With real-world, hands-on experience, Humboldt Polytechnic students will be primed to deploy clean energy systems that can help us cut greenhouse gas emissions and improve community resilience.

We will build a *modular and adaptable space where next-generation energy resources can be studied and advanced by students and researchers*. The professionals at the Schatz Energy Research Center will use the lab to develop and test new concepts for microgrids and integrating clean energy systems. Students, guided by staff and faculty, will use the facility to learn about these systems in lab exercises, class projects, and by assisting Schatz Center engineers installing real-world cutting-edge systems.

With these new laboratory capabilities, a range of systems can be analyzed to support instructional needs across multiple disciplines and a range of research projects.

- **Microgrids** - The core building block for resilient electricity systems to address wildfire risks and other threats to the power system, renewable microgrids increase resilience to the impacts of climate change and provide carbon-free electricity to the grid.
- **Renewable energy power systems -** Solar and wind power systems, battery storage, and related technologies are the clean-energy generation sources and energy storage systems that are needed to make microgrids and the larger grid sustainable and mitigate climate change.
- **Advanced electric vehicle chargers, heat pumps, and cooling -** The grid of the future will involve the use of flexible and efficient electric equipment that meets critical transportation, heating, cooking, and cooling needs with resilient clean energy.

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Laboratory Spaces
The facility will be built around four dedicated, custom-designed laboratory facilities that support education and research.

1. **State-of-the-art training laboratory & classroom -** A 12-station, 24-student lab equipped with grid simulation, signal generators, protection relays, etc., and electrically connected to the large research lab described below. Area: approximately 1,500 ft^2
2. **Ground floor, world class hardware-in-the-loop, grid simulation laboratory -** A large, high-bay lab space that houses control systems, high-performance computing simulation platforms, with the ability to test microgrid and other advanced grid systems. Area: approximately 1,500 ft^2
3. **Outdoor laboratory space -** Just outside roll-up doors from the ground floor lab space, the outdoor space will be a secure, safe, fenced area with electrical interconnection points and concrete slabs to mount outdoor-rated equipment under test. This flexible space will enable the lab to incorporate EV chargers, distributed battery storage systems, heat pumps, and other future energy systems. Area: approximately 2,000 ft^2
4. **Rooftop solar laboratory -** On the roof of the building, there will be a large, walkable "patio" lab space open to the sky for testing solar PV systems. With excellent access to sunshine, this space will be used to integrate real-time solar PV generation with the equipment and devices under test downstairs. Area: approximately 2,000 ft^2 (about half of the roof)

Supporting Infrastructure
These new facilities will be supported by The Schatz Energy Research Center's existing fabrication shop, meeting spaces, and general-purpose lab spaces. In addition, the new building will include additional support space for the Schatz Center Microgrid Lab, for new and existing staff. These spaces are conceived to primarily be on the second (and possibly third) floor of the new building, with a total of approximately 8,000 ft^2 of usable space.

- Faculty/Staff offices (10-12)
- Student workstations (10-12)
- Large conference room / space for hosting events
- Bathrooms
- Kitchenette with informal dining space
- Small meeting rooms
- Storage space

Support for HSU's Polytechnic Transition

Prepare students for what's next - The next decades of energy technology deployment in California will involve rapid deployment of solar power, batteries, electric vehicles, and microgrids to address the threat of climate change and adapt to the risks of wildfire and natural disasters. The **Distributed Renewable Energy and Microgrid Laboratory** will provide support for students and faculty across the University to learn about the basics of clean energy through demonstrations and educational tours. Students in the **Energy Systems Engineering, Mechanical Engineering, Software Engineering,** and other similar programs will also have

July 15, 2021

the opportunity to deeply engage with these technology systems through lab experiments and research projects. The facility would host ~300 students per semester in educational demonstrations, and support cutting-edge, practical laboratory courses and research work of more than 50 students per semester.

Cutting-edge opportunity - The specialized facilities required to test microgrid equipment and controls before they are operational in the field typically only exist at large electric utilities or national laboratories (the Schatz Center currently has to contract with these facilities to accomplish its work). The new hardware-in-the-loop, grid simulation lab will include a test facility that will be a public resource for educating the next generation of leaders at a world-class facility with many of the same hardware and high-performance computational platforms that they will later use to deploy clean energy systems across the state and nation. The facility will catalyze and support research by faculty and staff to advance clean energy systems, and will attract faculty scholars who value access to specialized grid simulation and testing equipment. These projects will directly benefit students who learn from these teachers in the classroom, and who get to participate as student research assistants in the work.

World-class expertise - The Schatz Center is a national leader in design and deployment of renewable energy microgrids, including two microgrids at Blue Lake Rancheria that have won national awards, and the Redwood Coast Airport Microgrid (RCAM), a first-of-its-kind, front-of-the-meter, multi-customer renewable microgrid integrated with PG&E's distribution system. The RCAM project is now the template for new microgrids being deployed by PG&E across their territory. Among other projects, the Center is currently supporting HSU Facilities Management to develop a campus-wide microgrid for the University. It will integrate renewable energy on campus, support continuity of operations through blackouts, and be designed with "living lab" elements to serve as an instructional example for students. This proposed lab facility will enable the Schatz Center to extend its current work to support new initiatives in the area, along with supporting the instructional needs at our emerging Polytechnic University.

Industry and policy collaboration - The Schatz Center is literally writing the manual for how to implement community microgrids in response to the threat of wildfire in California. Working closely with PG&E, experts from the Center are developing key technical documents that guide implementation of the Community Microgrid Enablement Program. The Schatz Center is also working closely with state, local, and tribal governments to identify effective deployment strategies and policies. Students at HSU will have the opportunity to work directly alongside these industry and government leaders as they continue to guide cutting edge practice for distributed and resilient energy systems.

Specialty Equipment & Services with Estimated Costs

The following equipment and staff time will be necessary to design, outfit, and commission the Distributed Renewable Energy and Microgrid Laboratory.

1. Classroom and Instructional Infrastructure *$2.5-3.0M*

Microgrid and Grid Protection Student Laboratory *$750k-1.25M*

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- Equipped with 12 student stations (2 students/station) including connection to grid simulator, signal generators, protection relay test systems, relays, and connection to the research hardware-in-the-loop test facility
- Instructor workstation

Student/Researcher Test Benches *$500k*
- 4 advanced grid simulation, protection, and control test benches that can be reserved by students or researchers for experiments
- these advanced stations will be housed in a separate room

Distributed Energy Tool Library *$500k*
- Extensive set of grid and distributed energy measurement tools including:
  - Portable, remote data loggers and varied electric grid sensors
  - Relay test sets and power analyzers
  - Complete electronics shop including oscilloscopes

Rooftop Laboratory *$250k*
- PV arrays and battery storage systems for student experimentation
- Rooftop room and storage area for computers and data logging equipment

Campus Microgrid Serving as a Living Lab *$500k*
- Outfitting the HSU microgrid with micro-synchrophasors and waveform capture instrumentation and connecting to the student lab

2. Research Laboratory Infrastructure *$3.75-5.25M*

Power-Hardware-in-the-Loop (PHIL) Simulator *$2.5-3.5M*

This is a world-class microgrid research tool located in a large 2-story laboratory space that includes:
- Power capability to 200 kW
- A real time digital simulator
- Capability to test mid-feeder operation
- Protection for the campus grid
- Hardware and software to simulate a complex grid environment
- EV and chargers to test vehicle to microgrid integration

Supporting Infrastructure for the PHIL Facility *$1.0-1.25M*

The entire laboratory building will be electrically sectioned so that it can be integrated into the PHIL testing capability including:
- Electric heat pumps and heat pump water heaters
- An outside laboratory area including large batteries and PV arrays, EV chargers and EV, other variable loads

Computing infrastructure *$250k-500k*
- High power computing core for complex simulations, calculations, and processing of large data sets
- Secure, climate-controlled room for this equipment

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3. Staff Time for Design, Construction Management Support, & Commissioning *$0.75M*

Schatz Center staff will be needed to:

- Help write the RFP for the facility and evaluate resulting proposals
- Coordinate with FM during construction
- Help commission the lab equipment

A specialist will be hired to help commission and calibrate the PHIL facility (1 FTE for 1 yr).

The cost range for equipment and services is $7.0-9.0M. The midpoint cost is $8.0M.

7.2 INITIAL SUSTAINABILITY CENTER NARRATIVE

Sustainability Center

What it is:

- The hub for sustainability activities and initiatives on campus.
- The first stop for prospective/current students, faculty, staff and general public interested in sustainability and getting involved
- Distinct concept areas in the building.
  - workshop/conference/training space
  - Informal communal space
  - Focus professional staff space (offices/shared workspace)
  - Student work space (groups, stations, storage, collaboration areas)
  - Interpretive center to connect campus visitors to sustainability across the campus. There would be interactive displays.
  - Outdoor classroom
- Physical space, in relationship to the distinct areas.
  - Library, (books, tool check-out, seeds, etc),
    - Examples of prior projects
    - Written Materials (books, articles, ,
    - Tools (energy data loggers, etc.)
    - Hardcopy films
  - Lounge/informal space, touch point for visiting students, faculty and staff. promoting a community
  - Student workspaces
  - Conference room, medium up to 10 people
  - Lecture Room, space for workshops/screenings/lectures
  - Gallery space
  - Staff workspaces (Offices)
  - Shared work space w/3 person conf space
  - Community touch point (when you step in somewhere and you want to find sustainability, what does that look like?)
  - Work Room/Storage; posters, pins, shirts, creating materials, general office machines
  - Kitchen
    - Place to store and wash durable dishes and utensils
    - Refrigerator & freezer
    - Small stove to cook on or prepare lunch food
    - Ample space for compost bucket and waste sorting
- Focus for coordination and support of HEIF, Green Campus, Sustainability Committee, other relevant org's, Earth Week Every Week (Associated Students Committee)
- Hub for the Green Scene
- A place to showcase or make the Humboldt Sustainability Dashboard come to life

What it manifests:

- Works with campus partners to integrate sustainability into operations, goals and programming. Campus facilitators, outreach and training.
- Bridge between campus and community for sustainability/climate resilience activities and initiatives
  - Facilitate interdisciplinary applied research for the City of Arcata and other community partners
  - A touch point for collaborating on grants
- Provides experiential learning and leadership opportunities for students outside of the classroom - Student Leadership Institute for Climate Resilience (SLICR), EcoReps, volunteer, intern, paid positions...
- Facilitates professional development opportunities for faculty and staff in sustainability
- Coordinates Earth Week or annual sustainability/resilience summit
- Opportunities to host networking and social events where food could be served (less formal) or screenings could happen (films or keynote speakers)
- A place to cultivate ideas to integrate sustainability from the classroom to the campus to the community (nested model)
- A place to advertise & advise on sustainability minors & certificates
- A place to learn about sustainability designated courses, internships
- Homebase for the Sustainability Learning Community (PBLC)
- Space to host field trips for K-12 students; teacher workshops

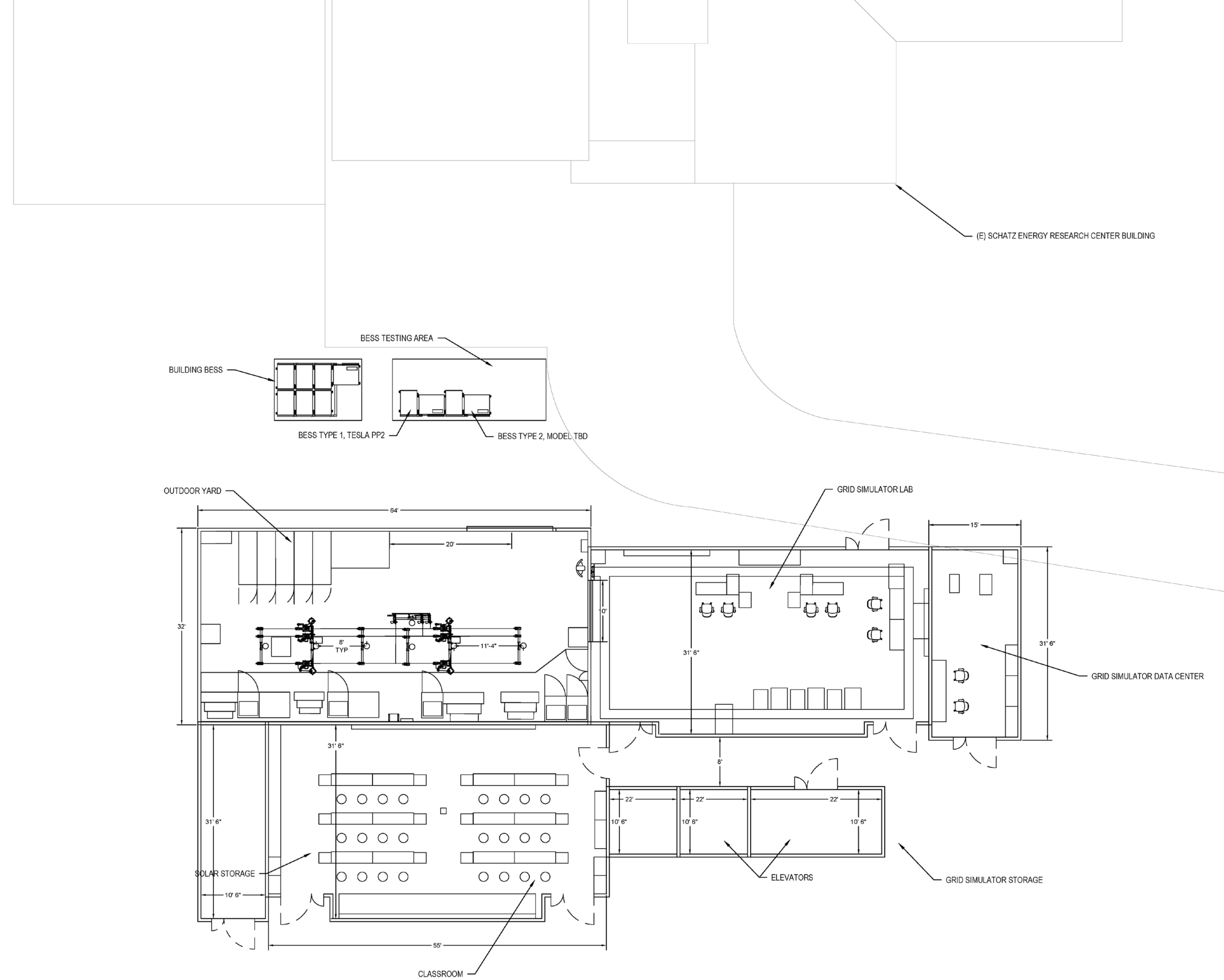
Physical Sustainability elements

- Any redwoods/high value trees cut down will be milled and used on site
- No net tree loss - campus will plant a tree for every tree lost
- LEED Platinum
- Designed to maximize natural lighting and passive solar heating
- Zero net energy/all-electric
- Rainwater catchment
- Greywater treatment
- Rain gardens to capture run-off
- Living wall
- Native/cultural/bee-friendly plant landscape (possibly edible/medicinal?)
- Zero waste building
- Building dashboard
- Bike lockers, repair kiosk, shower and e-bike charging station
- Kitchens- maybe commercial for food prep, maybe just for break time/ employee space?
- Living roof
- Gender inclusive bathroom

Center for Sustainability example

Coordinate Student focus groups asking the question what they would want to see out of a sustainability center?

7.3 ENERGY RESEARCH SPACE PLANS / SINGLE LINE DIAGRAM



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OFFICE OF RESEARCH AND SPONSORED PROGRAMS

1"=10' 0 10' 20'

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NOT FOR CONSTRUCTION

STAMP

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SCHATZ ENERGY RESEARCH CENTER

REV	DATE	
2	08/09/22	DRAFT
1	08/08/22	DRAFT
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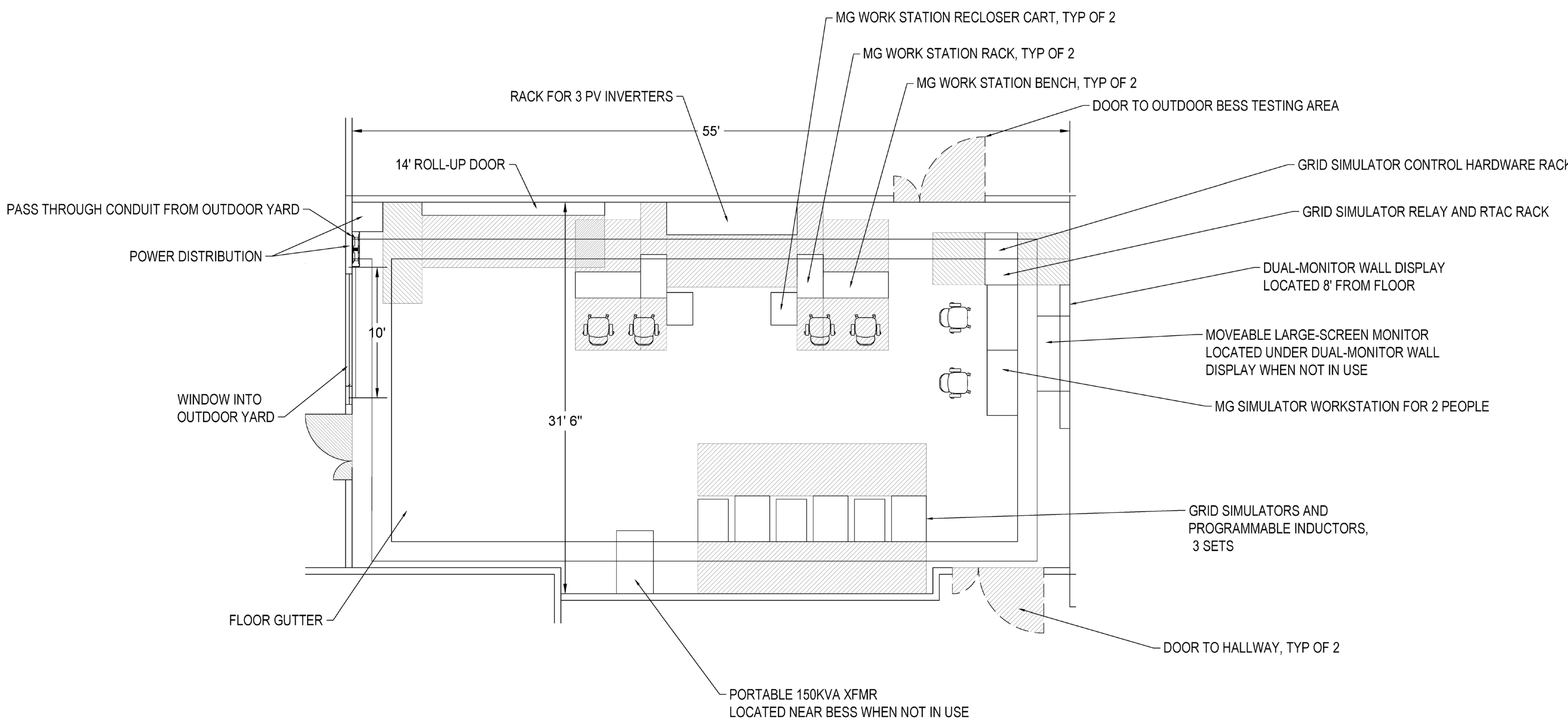
ENERGY RESEARCH AND SUSTAINABILITY BUILDING

SITE PLAN

DRWN: . CHK: .

G-03

SHEET 3 OF XX



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SCHATZ ENERGY RESEARCH CENTER

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ENERGY RESEARCH AND SUSTAINABILITY BUILDING

GENERAL ARRANGEMENT
GRID SIMULATOR LAB

DRWN: . CHK: .

GA-01

SHEET 4 OF XX

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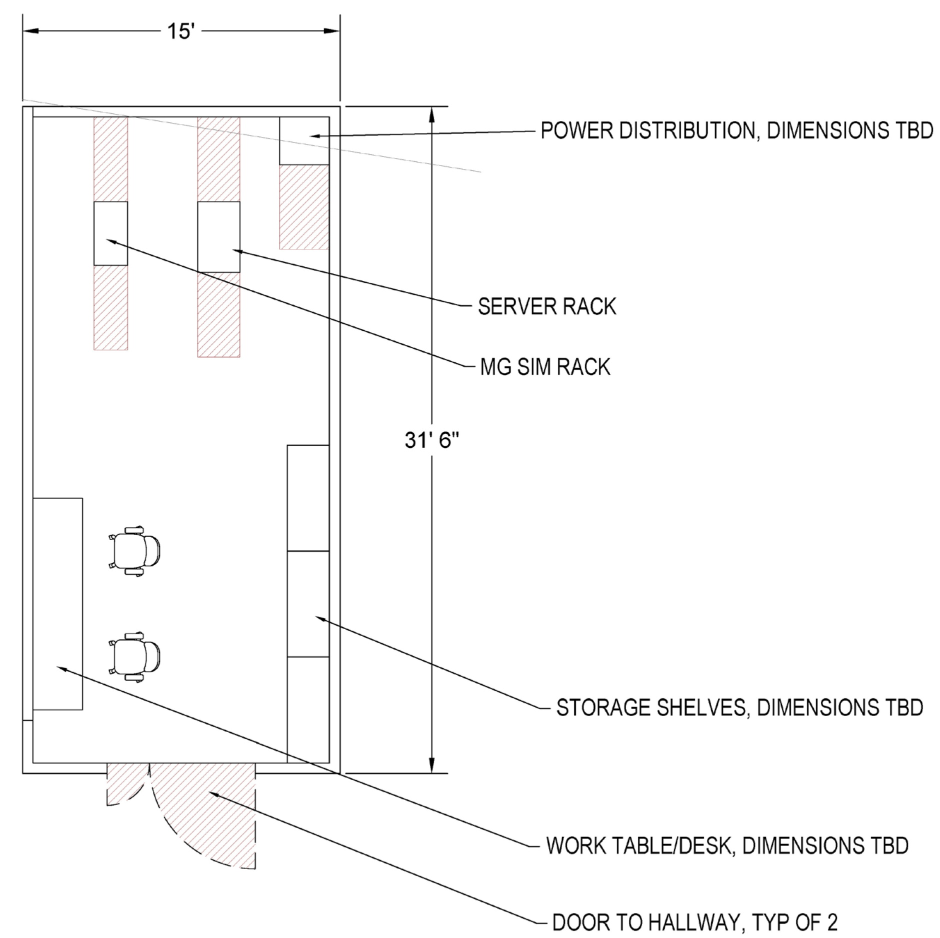

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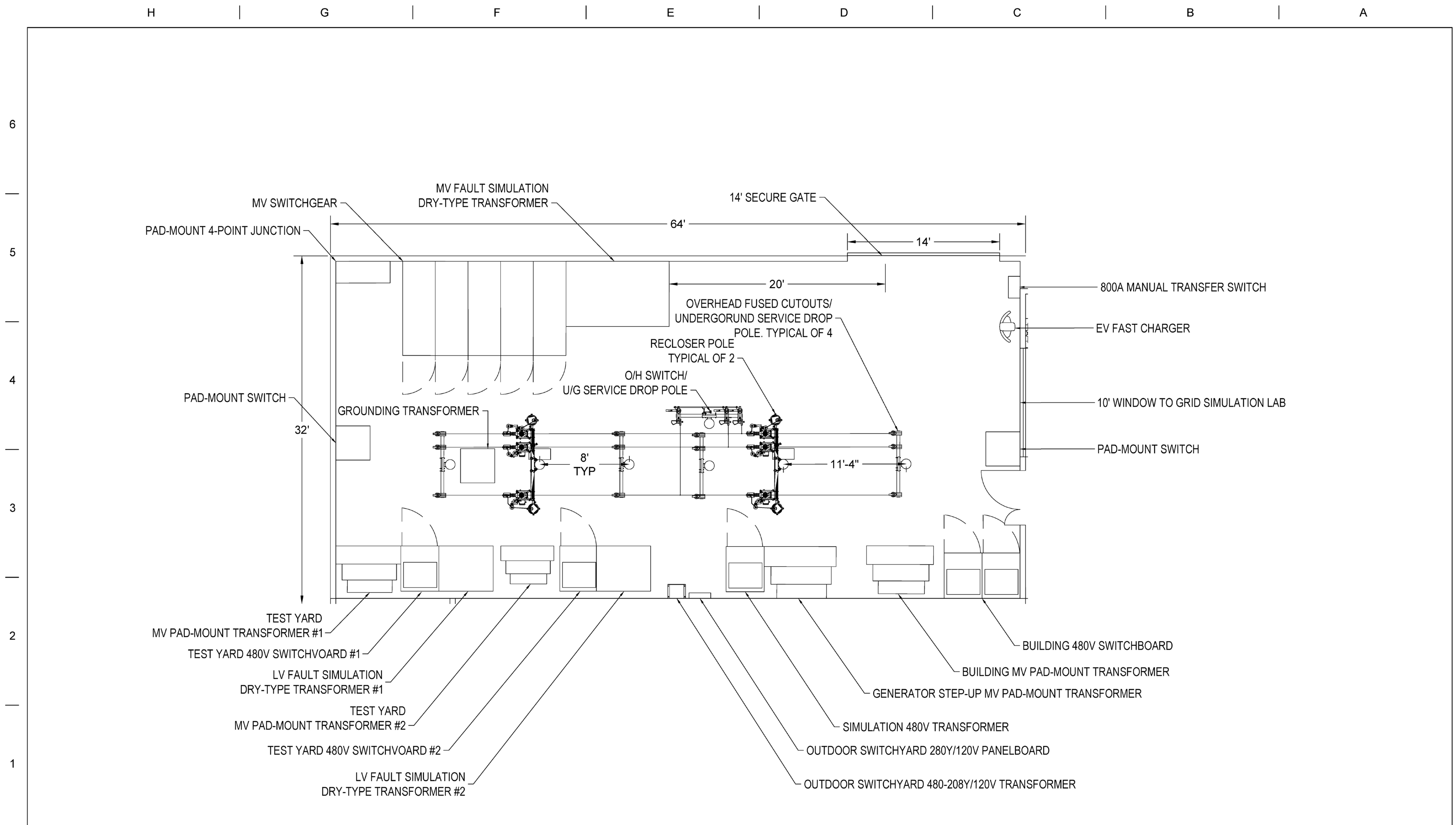
ENERGY RESEARCH AND SUSTAINABILITY BUILDING

GENERAL ARRANGEMENT
DATA CENTER

DRWN: . CHK: .

GA-02

SHEET 5 OF XX



CAL POLY HUMBOLDT · ESTABLISHED 1913
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2	08/03/22	DRAFT
1	08/02/22	DRAFT
0	7/15/22	DRAFT

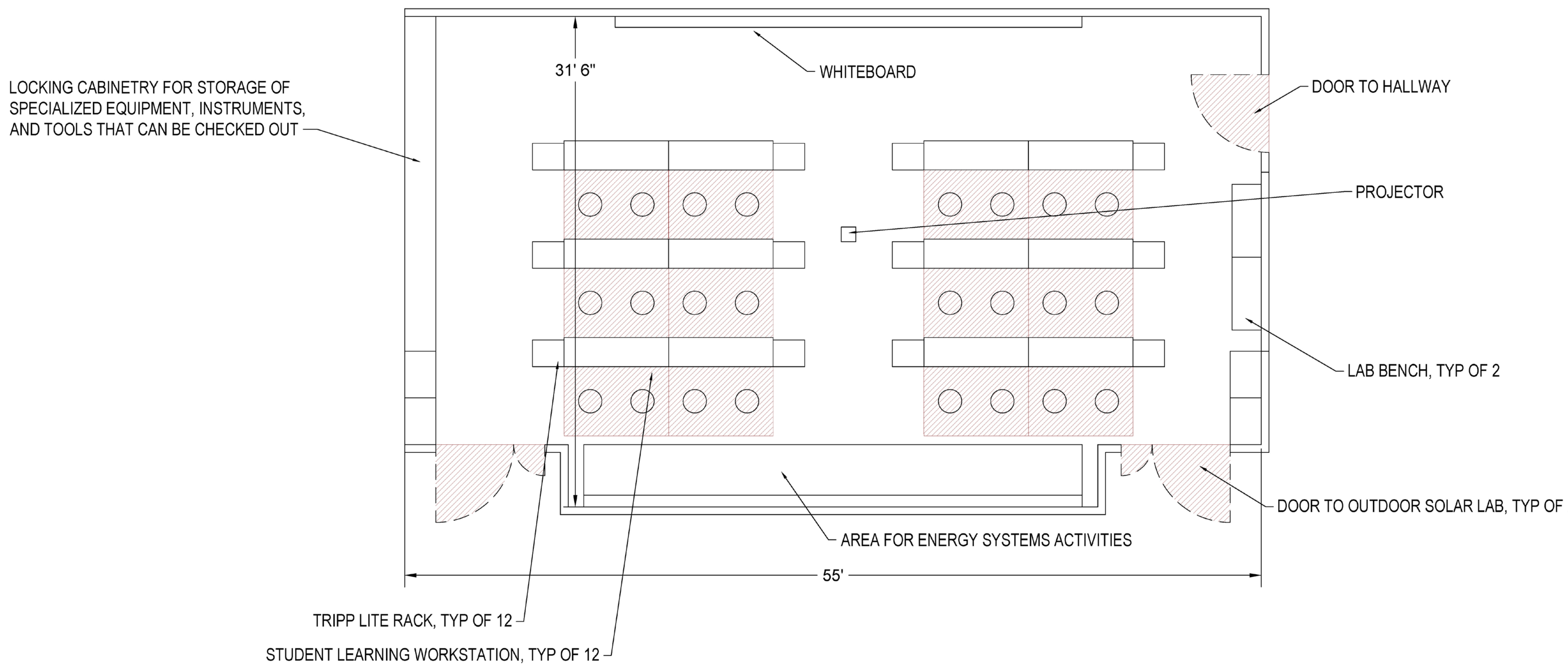
ENERGY RESEARCH AND SUSTAINABILITY BUILDING

GENERAL ARRANGEMENT
OUTDOOR LAB

DRWN: SR CHK: DC

GA-03

SHEET 6 OF XX



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SCHATZ ENERGY RESEARCH CENTER

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ENERGY RESEARCH AND SUSTAINABILITY BUILDING

GENERAL ARRANGEMENT CLASSROOM

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GA-04

SHEET 7 OF XX

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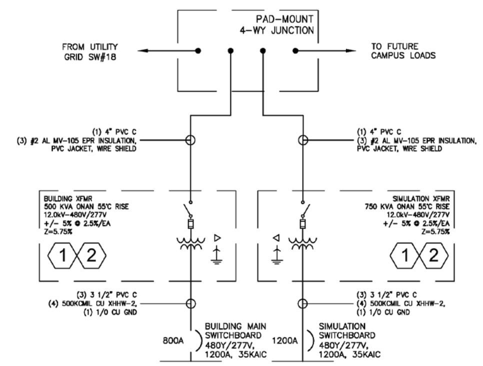

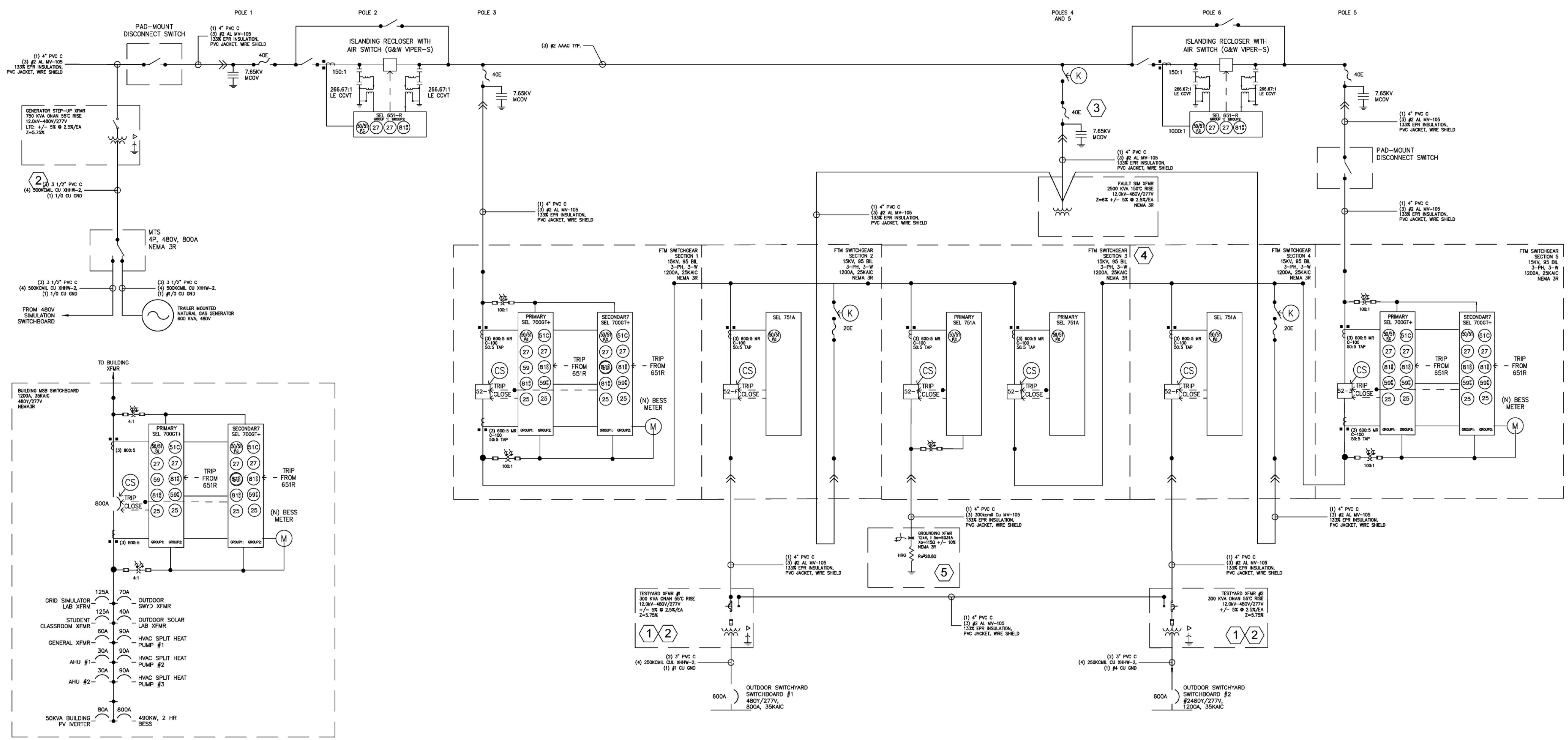

SHEET KEYNOTES

1. PROVIDE FULL-RANGE TRANSFORMER FUSE PROTECTION.
2. IN ADDITION TO WHAT IS SHOWN, CONTRACTOR TO PROVIDE LOOP-FEED, TRANSFORMERS WITH:
   - 2.1. FR3 OR EQUIVALENT INSULATING FLUID
   - 2.2. RTDS
   - 2.3. OIL TEMP, VACUUM, FLUID LEVEL ALARMS.
3. OVERHEAD SWITCH SHALL BE PROVIDED WITH A GROUND-LEVEL OPERATOR
4. BUS BARS AND HARDWARE SHALL BE PROVIDED TO RECONFIGURE FOR DELTA OR WYE.
5. TRANSFORMER RATINGS MEET OR EXCEED IEEE 1547 REQUIREMENTS FOR GROUNDING TRANSFORMERS:
   - 5.1. X0 = .6 pu
   - 5.2. X0/R0 ≧ 4
   - 5.3. V0 WITHSTAND = 4%
   - 5.4. 5S WITHSTAND CURRENT > AVAILABLE FAULT CURRENT (6031A 2 30 CYC)

CAL POLY HUMBOLDT ESTABLISHED 1913
OFFICE OF RESEARCH AND SPONSORED PROGRAMS

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SCHATZ ENERGY RESEARCH CENTER

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2	08/03/22	DRAFT
1	08/02/22	DRAFT
0	7/15/22	DRAFT

ENERGY RESEARCH AND SUSTAINABILITY BUILDING

ELECTRICAL
SINGLE LINE DIAGRAM

DRWN: SR CHK: DC

E-00

SHEET 11 OF XX

7.4 ENERGY RESEARCH SUPPLEMENTAL ITEMS

Schatz Energy Research Center

Supplemental Information

Supplemental Notes for Outdoor Test Yard:

(1) 4-way junction for incoming power, building and test yard service power, and for a future tap
(1) Overhead line section on wood poles meeting IEEE-C2 National Electrical Safety Code (2007) clearance requirements
(2) pad-mount switches for overhead line isolation
(2) line reclosers for simulation microgrid isolation
(3) underground service drops with fuse cut-outs and surge protection for:

- Microgrid feeder, End of the line feeder, MV fault simulation transformer

(1) Overhead to underground service drop with fused cut-outs, surge protection, and an ground-operable overhead switch for a medium voltage fault simulation transformer
(1) 500kVA medium voltage, pad-mount transformer for building service power
(1) 1200A main building 480V switchboard for building service power with a connection for a battery energy storage system for building back-up power and a motor-operated main breaker with relays for islanding supervision and protection
(1) 750 kVA medium voltage, pad-mount transformer for test yard service power
(1) 1200A simulation switchboard for test yard power low voltage distribution
(1) 2500kVA medium voltage dry-type transformer for microgrid medium voltage fault simulation
(1) 800A manual transfer switch for test yard off-grid power
(1) 750kVA medium voltage, pad-mount transformer for generator power step-up to 12kV line voltage
Space for a 600kVA trailer-mounted natural gas generator
(1) medium voltage switchgear line-up for microgrid power distribution, protection, and control
(1) medium voltage, pad-mounted zig-zag grounding transformer for overvoltage limitation
(2) 300kVA medium voltage, pad-mount transformers for microgrid and end-of-the-line low voltage power distribution
(2) 800A 480V switchboards for microgrid and end-of-the-line distributed generation and load low voltage power distribution
(2) 1000kVA low voltage, dry-type transformers for microgrid low voltage fault simulation
(1) 45kVA 208Y/120V transformer and panelboard for switchyard auxiliary low voltage power distribution
(1) Electric vehicle fast charger
Mast lighting and video surveillance
(1) 14-foot secure entrance gate
(1) 10’-wide window for test yard monitoring from the grid simulation lab
(1) secure access door between the test yard and the grid simulation lab

Schatz Energy Research Center

Supplemental Information

Suggested Content: 5.7.7 General Materials
Outdoor Test Yard

Medium voltage simulation test yard shall be designed to IEEE standards

All equipment shall be seismically rated for site conditions

All equipment shall be rated or coated for near ocean environment

Overhead line section on wood poles shall meet IEEE-C2 National Electrical Safety Code and CPUC GO-95

Switchyard grounding system shall meet safe step and touch potentials in accordance IEEE-80 2013

Communications circuits into and out of the switchyard shall be fiber optic only

Pad-mount 4-way junction shall be S&C or equivalent and shall be installed in accordance with PG&E document #066212 INSTALLATION OF PAD-MOUNTED, LOAD-BREAK JUNCTION

Pad-mount switches shall be S&C PMH-3 or equivalent and shall be installed in accordance with PG&E document # 053318 PAD-MOUNTED, LOAD-BREAK SWITCHES AND FUSES

Overhead fuse cutouts shall be S&C type XS or equivalent.

Underground services shall be designed and installed in accordance with applicable sections of PG&E document #TD-7001M ELECTRIC & GAS SERVICE REQUIREMENTS 2022-2023 (Greenbook) and PG&E document # 038193 MINIMUM REQUIREMENTS FOR THE DESIGN AND INSTALLATION OF CONDUIT AND INSULATED CABLE and shall include surge protection

Overhead switch shall be S&C Omni-Rupter® or equivalent and shall be installed in accordance with PG&E document #066195 25 KV UNDERARM SIDE-BREAK SWITCH

Pad-mount transformers shall be Eaton loop-feed transformers designed in accordance with IEEE C57.12.34 2015 with:

- Primary under-oil disconnect switches and current limiting fuses
- FR3 or equivalent insulating fluid
- RTDS
- Oil temperature, vacuum and fluid level alarms

Building and test yard service transformers shall be provided with full-range fuse protection

Generator step-up transformer shall be provided with a load tap changer

Pad-mount transformers shall be installed in accordance with PG&E document #045292 CONCRETE PAD FOR THREE-PHASE, LOOP-STYLE, PAD-MOUNTED TRANSFORMERS

Schatz Energy Research Center

Supplemental Information

Dry-type transformers shall be listed to UL 1561 and 1562

Grounding transformer ratings shall meet IEEE 1547 requirements for grounding transformers

Medium voltage switchgear shall be designed in accordance with IEEE-C37.20.2-2015 and as amended by C37.20.2a-2020.

Low voltage switchboards shall be listed to UL 891

Spare conduit between the simulation switchboards and the Grid Simulation lab shall be provided

Battery Energy Storage system shall be UL listed to 1741-SA and 9540 as amended by 9540A. Installation shall meet the requirements of NFPA 855

Electric vehicle fast charger shall be V2G capable and UL 1741-SA listed if available at the time of construction

Photovoltaic system shall meet the requirements of CEC Article 690 and shall meet the access and pathways requirements of the CFC.