FEASIBILITY STUDY FOR

USU MOAB CAMPUS PHASE 1 BUILDING

UTAH STATE UNIVERSITY

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FEASIBILITY STUDY REFERENCES

DFCM High Performance Building Standard

LEED v3, v4 for New Construction and Major Renovations

2012 International Building Code (IBC)

2012 International Fire Code (IFC)

2012 International Plumbing Code (IPC)

2012 International Mechanical Code (IMC)

2011 National Electrical Code (NEC)

2012 International Energy Conservation Code (IECC)

2009 ANSI/A117.1

2012 International Plumbing Code (IPC)

2012 International Fuel Gas Code (IFGC)

Brad Lancaster, Rainwater Harvesting for Drylands

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01.

EXECUTIVE SUMMARY

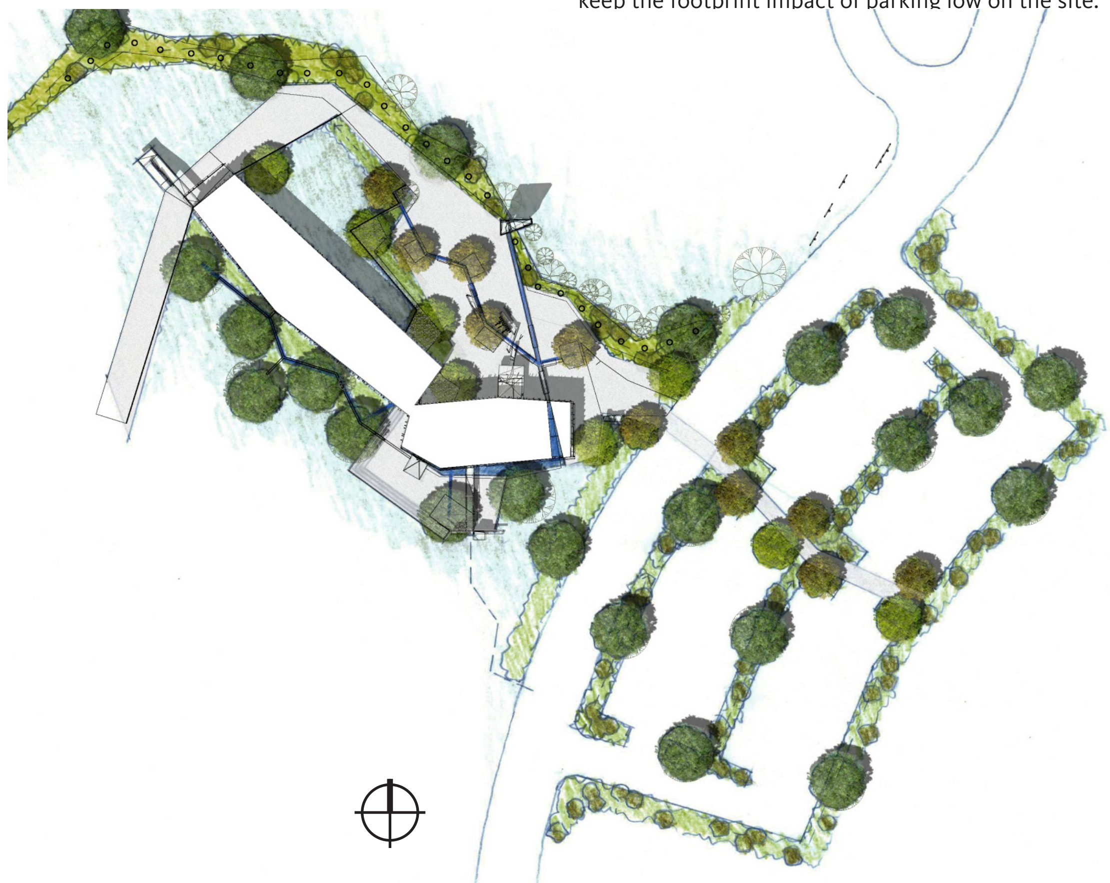
30 YEAR SITE MASTER PLAN

PROJECT VISION, GOALS, NEEDS AND CONCEPTS

At the heart of the Master Plan for the USU Moab Campus is creating an education facility that embodies a strong sense of place - integrated with the landscape aesthetically and functionally, being intrinsically a textbook in itself to the student body.

SITE INFORMATION

The plan of the proposed building reflects the linear nature of the campus master plan which is organized along a central pedestrian spine that takes advantage of a flat portion of the site. An access road coming from the Highway to the north divides the core of the academic campus from the parking side to create a pedestrian friendly experience. This first building, with it's sculptural landmark and welcoming entry courtyard holds the space for the first of a series of campus 'pods'. These will consist of buildings arranged around central courtyards, defining where designed and programmed exterior spaces will be developed. Rainwater harvesting landscape features integrate the building from the roof into the landscape and extends the space of the campus pods into the network of trails through the remainder of the site which will be preserved and restored native vegetation. The trails further connect the campus to the surrounding wilderness areas and to the community of Moab. As the phasing progresses, the parking to the East of the road will eventually be succeeded by a building and parking structure to keep the footprint impact of parking low on the site.



USU MOAB PHASE ONE BUILDING LANDSCAPE PLAN

ENVIRONMENT AND CLIMATE

Ecologically speaking, the land for the new campus of Utah State University-Moab is an upland desert of the Colorado Plateau. This ecosystem is relatively barren except for a few high UV and extreme-dry tolerant shrubs, grasses, and forbs. Moab in particular is a transition ecosystem in many respects due to the close proximity to high mountains and major riparian corridors. The new campus site however, is fully representative of non-riparian, non-mountainous overgrazed Colorado Plateau, which originally consisted of shrubby grasslands with Pinyon-Juniper woodlands scattered throughout. As such it is quite a harsh environment and one imperative of the design process is to create a sense of habitability and shelter within it. Restoring and integrating a woodland ecosystem is one approach to accomplishing this.

SITING CONSIDERATIONS

Two sites within the Master plan were considered for the location of the phase one building. The first was the site of the building study included in the master plan itself (towards the south end of the campus, maintaining the sequence of phasing described in it. The second site was on the farthest north end of the site, requiring less initial infrastructure cost in roads and utilities, but reversing the order of phasing. USU determined that the second site would be the best suited.

SPACE LIST

During the community workshop the essential resources for this first campus building were identified and were further refined during the feasibility study process. The building will accommodate an estimated 350 full time equivalent students (composed of a range of full and part-time as well as traditional and non-traditional/distance learning students). The spaces included in the proposed design are as follows:

ACADEMIC SPACES

- 6 Classrooms
- 2 Large Classrooms/Small Conference Rm.
- Wet Lab
- Dry Lab
- Computer Lab
- Online Classroom
- 6 Seminar Rooms

ADMINISTRATION/FACULTY

- Faculty Offices
- Administration Offices

STUDENT SERVICES

- Student Commons
- Coffee Bar
- Registrar
- Academic Support
- Testing

BUILDING SUPPORT

SCHEME ANALYSES

Three schemes were identified and developed to study how the required spaces could be accommodated within the site. Each scheme was also considered carefully in it's effect to the overall budget. The comparison of the footprints of the three options can be seen in figure 1.1.0.

OPTION 1: ONE-STORY.
See Figure 1.1.1.

OPTION 2: TWO-STORY WITH A ONE-STORY WING
See Figure 1.1.2.

OPTION 3: FULL TWO-STORY
See Figure 1.1.3.

Of the three schemes, Option 3 was selected for further development, for its compact footprint and low impact on the site, and because it is very evocative of the natural landscape of the Moab area.

BUILDING ORGANIZATION

The organization of the building is characterized by its fluid connections and views to the landscape, providing the students with a space that meets the needs of their curricula but that also naturally fosters learning. It is a textbook in that it provides the building users with a multiplicity of opportunities to interact with the ecology of the site, its weather patterns and essential characteristics. At the core of the building is the student commons which is accessed from the parking and entry courtyard on the North as well as from the South facing courtyard/amphitheater. Both courtyards integrate seating sheltered from the sun as well as edible 'forest garden' plantings watered by acequias (rainwater harvesting channels) formed into the concrete. The commons area, a two-story atrium space, connects the classroom/academic wing in the west to the east wing which houses Administration,

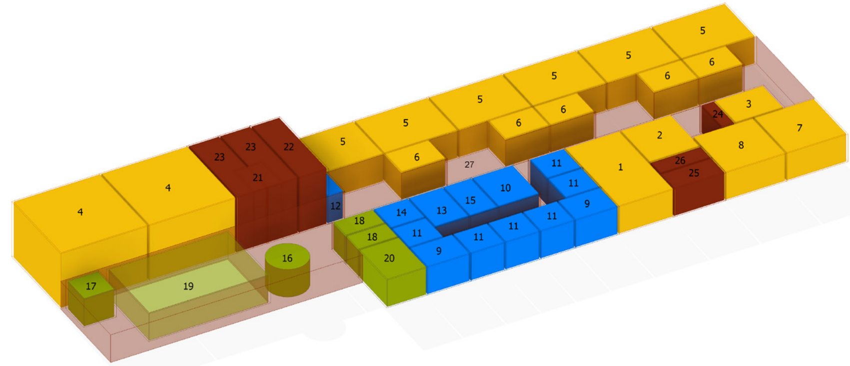
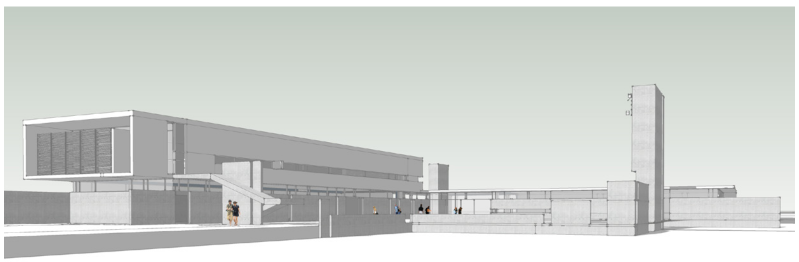


FIGURE 1.1.1 - OPTION 1 - ONE STORY



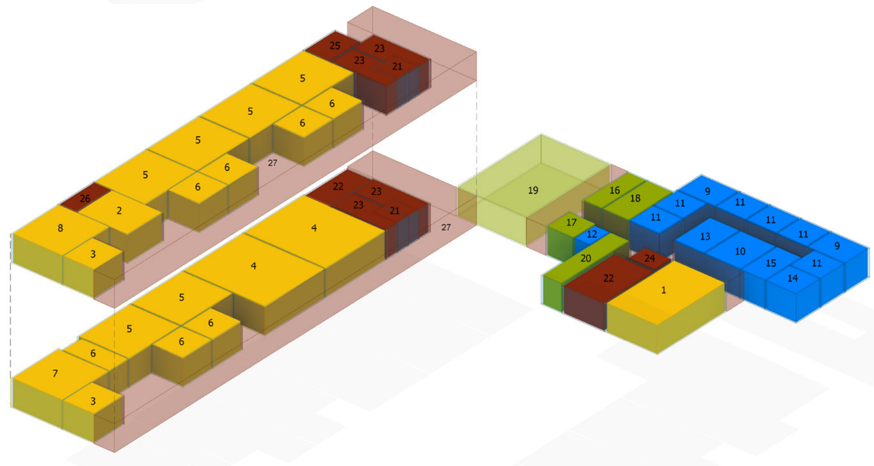
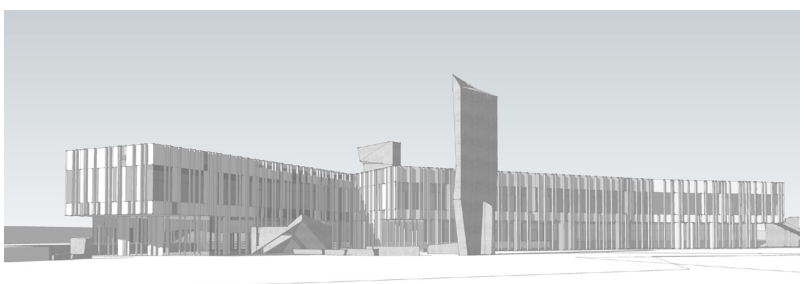


FIGURE 1.1.2 - OPTION 2 - TWO STORY WITH A ONE STORY WING



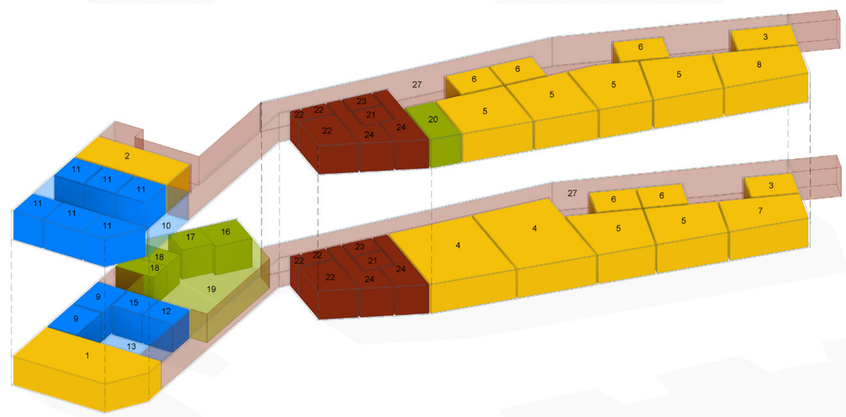
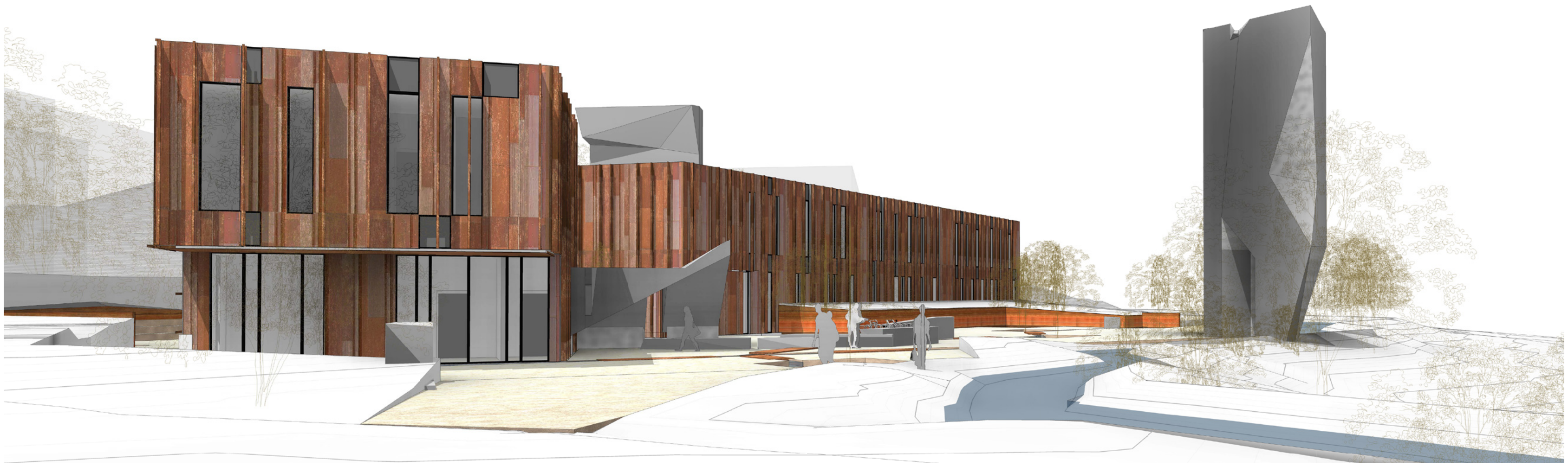
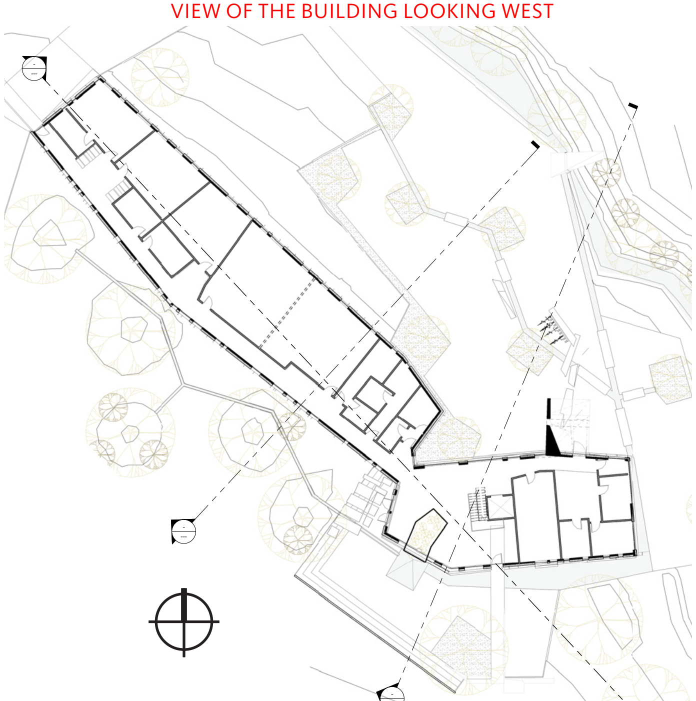


FIGURE 1.1.3 - OPTION 3 - FULL TWO STORY



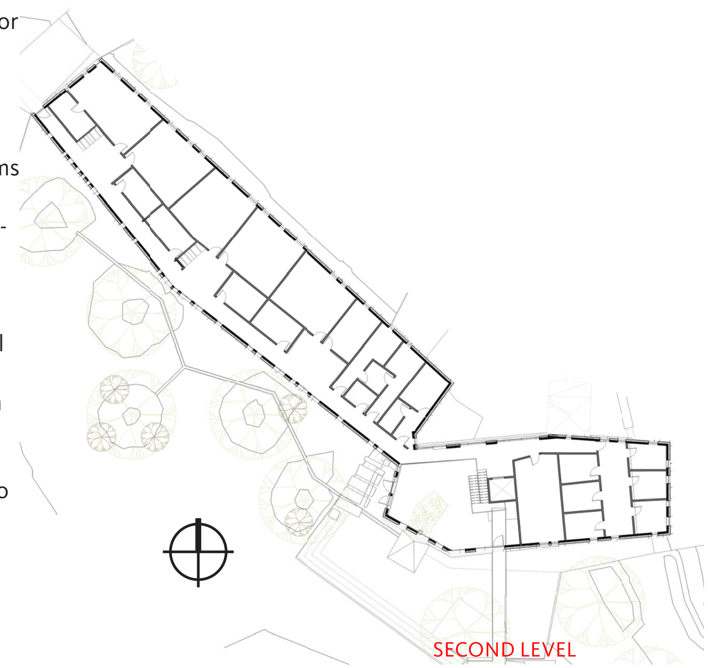
VIEW OF THE BUILDING LOOKING WEST



MAIN LEVEL

Faculty, Student Services and Computer Labs. The building will thus serve as a 'workhorse' facility for the new campus, able to act as classroom space, student union, and small conference center all in one. The classroom wing is structured along a wide day-lit corridor which has large informal learning spaces at the entrances to the classrooms with soft seating, study tables and white-board walls, where spur of the moment cross-collaboration is instigated and fostered.

The building skin on the is evocative of the landscape - its layers and stratifications, both vertical and horizontal; but it also acts as a screen or a filter that opens, closes and dissipates entirely in the commons area - allowing building occupants glimpses of the landscape and its monuments, and in turn opening up entirely for the student to be immersed in the view of it.



SECOND LEVEL

NORTH ELEVATION

SUSTAINABILITY

Given the sustainability requirements stipulated by the State of Utah (DFCM), and Utah State University, as well as the goals established during the community charrette, reflecting the regional values and imperatives, several analytical models were used to evaluate the performance of the selected scheme to establish strategies for meeting the goals by the merit of the building form and orientation.

Targets identified in the charrette were a 20% reduction in energy use over code, LEED Gold, and 'net zero' water for landscape irrigation. Strategies to meet these goals were also evaluated and balanced with an eye to the budget, and it was found that realizing them is reasonable. Strategies include exterior shading devices, improved envelope insulation, rainwater conveyance and storage systems, and solar photovoltaic panels.

COST MODEL SUMMARY

A significant effort was made during the process to evaluate and track the project budget, balancing it with the project needs and goals. The initial project budget was identified at $6-7 million. After a 20% reduction for soft costs from $6,000,000 the initial working budget became $4,800,000 for the building cost. After developing the plan to meet the requirements of the space lists and the project goals, the project construction hard cost estimate came in at $5,882,263. This would put the total project cost at $7,352,828 including soft costs, which USU Moab accepted as a feasible project cost.

SOUTH ELEVATION

02.

FEASIBILITY STUDY PROCEDURE

COMMUNITY WORKSHOP

The goal of the workshop was to re-engage the community with the project and to re-visit the findings in the master plan completed in March of 2012 and confirm these principles align with the first building planned for the campus. Also the space program needed to be re-aligned with new budget requirements reducing the project costs from $15,000,000 to closer to $7,000,000. Other topics that were discussed with the group were sustainability goals, the location of the first building on the campus and aesthetics.

Regarding the space needs for the building, the group decided that the first building on the campus need not contain all the elements that were included in the original program in the master plan. Labs, for example, could be reduced and the first building need not contain the multipurpose auditorium previously identified. The building should be a “workhorse” education center with flexible spaces that can serve multiple functions.

While LEED Silver certification is the requirement for Utah State University, it was felt that the project should aim for LEED Gold or higher, depending on the cost to benefit evaluation as the project moves through the design process.

In the master plan, the first building was slated to go on the south end of the parcel. The location of the first building was opened up for discussion and re-evaluated. The consensus was that a location on the north end of the parcel would significantly reduce utility infrastructure costs and should be considered. There were also synergies seen between this north site location with the SITLA development envisioned just across this northern property line. Potential student housing and shared parking between the two developments were discussed.

Finally, the original aesthetic guidelines identified for the first building on the campus were re-visited. The consensus was that these original design choices would still resonate with the greater Moab community and were appropriate for the setting (landscape and topography) of the building.

03.

SITE CONSIDERATIONS

USU MOAB - 30 YEAR MASTER PLAN

SITE PLAN

BUILDINGS AND LANDSCAPE reflect a hidden curriculum that powerfully influences the learning process. The curriculum embedded in any building instructs as fully and as powerfully as any course taught in it.

David Orr, PhD, Environmental Educator

THE MASTER PLAN

The Utah State University Campus in Moab will be located just to the south of town, on the East side of Highway 181 as shown in the Campus Vicinity Map. The following quote from the master plan conducted by Design Workshop and EDA Architects, describes the vision for the campus at the 30 year build-out:

The proposed master plan for the Utah State University future Moab campus as represented in this graphic (SITE PLAN at left) is based on a 30-year build-out projection.

The buildings within the plan are organized to minimize impact on existing site conditions including natural drainages, vegetation and prominent topographic features .
The central pedestrian spine illustrated in the plan is the main circulatory route for pedestrians on campus . This spine also acts an emergency access route for fire trucks, ambulances and police cars.

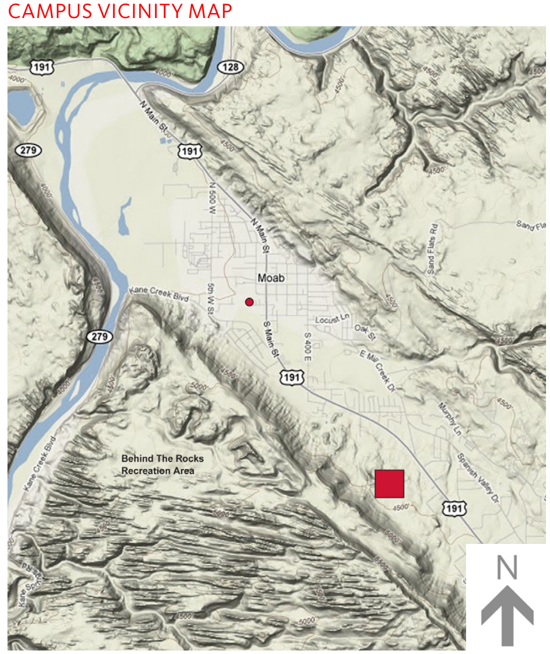
Buildings on the campus primarily house academic functions but other proposed uses include a student union, a small retail center, a central heating and cooling plant and government agency facilities . Two parking garages will accommodate all the parking demands for the build-out of the campus . These garages will step down the natural grade and will be sunk into the topography to minimize their visual impact .

The aesthetics of the campus landscape and buildings will be derived from the natural character of the region . Materials, colors and textures will be referenced from the immediate context and much of the campus landscape will reflect the natural existing conditions.

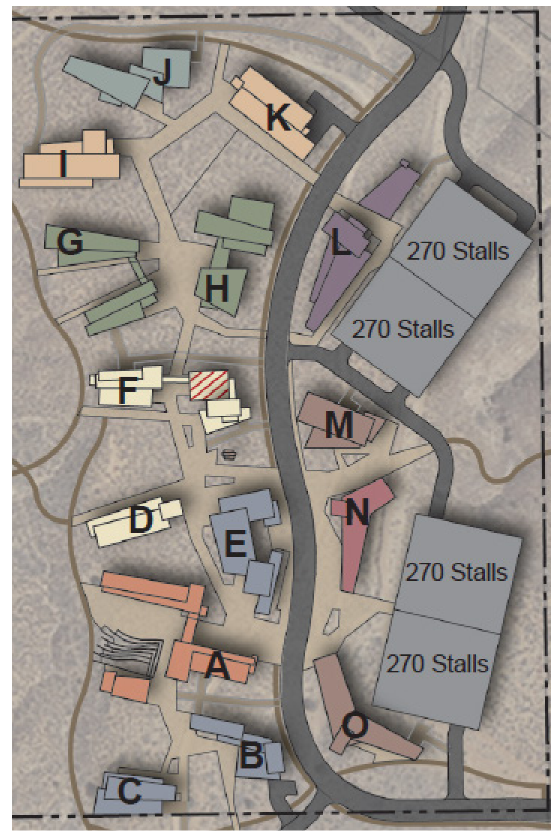
THE SITE

In the Campus plan to the right Building 'A' was designed by EDA to be the starting point of the development. The subsequent phasing was envisioned in 5-8 phases, progressing from the south down-hill to the north end of the site. However for this feasibility study and re-visioning of the first building of the new campus, the direction of the phasing was re-considered. In order to reduce the initial costs associated with developing the full road and utilities to the farthest south end of the site, it was determined by USU to select the alternate building site of Building 'K' at the North-most end of the new campus. This would allow for the lower initial investment in infrastructure to establish the campus, and the incremental development of the road infrastructure as the campus grows.

CAMPUS VICINITY MAP



CAMPUS PLAN



04.

BUILDING ORGANIZATION

BUILDING SPACE LIST

The spaces identified in the community workshop and in meetings with USU for this first building were

	Number	Unit	NSF	Occupants	Total Occ.	Cost/SF	Cost Estimate
Academic Spaces							
Large Classroom	2	850	1,700	40	80	$300.00	$510,000.00
Flex/Medium Classroom	6	450	2,700	20	120	$300.00	$810,000.00
Seminar Room/Conference Room	5	150	750	12	60	$300.00	$225,000.00
Group Online Classroom	1	300	300	8	8	$300.00	$90,000.00
Computer Lab	1	600	600	20	20	$300.00	$180,000.00
Wet Lab	1	400	400	32	32	$400.00	$160,000.00
Dry Lab	1	400	400	32	32	$400.00	$160,000.00
Lab Storage	1	200	200	0	0	$300.00	$60,000.00
Subtotal - Academic			7,050		352		**$2,195,000.00**

	Number	Unit	NSF	Occupants	Total Occ.	Cost/SF	Cost Estimate
Administration and Faculty							
Administrative Office	2	150	300	1	2	$300.00	$90,000.00
Faculty Office	6	120	720	1	6	$300.00	$216,000.00
Staff Office	1	120	120	1	1	$300.00	$36,000.00
Receptionist	1	200	200	1	1	$300.00	$60,000.00
Copy/Mail/Supply Room	1	150	150	0	0	$300.00	$45,000.00
Faculty Break room	1	100	100	12	12	$300.00	$30,000.00
Mothers Room	1	50	50	2	2	$300.00	$15,000.00
W/C	2	100	200	0	0	$300.00	$60,000.00
Subtotal - Admin and Faculty			1,840		24		**$552,000.00**

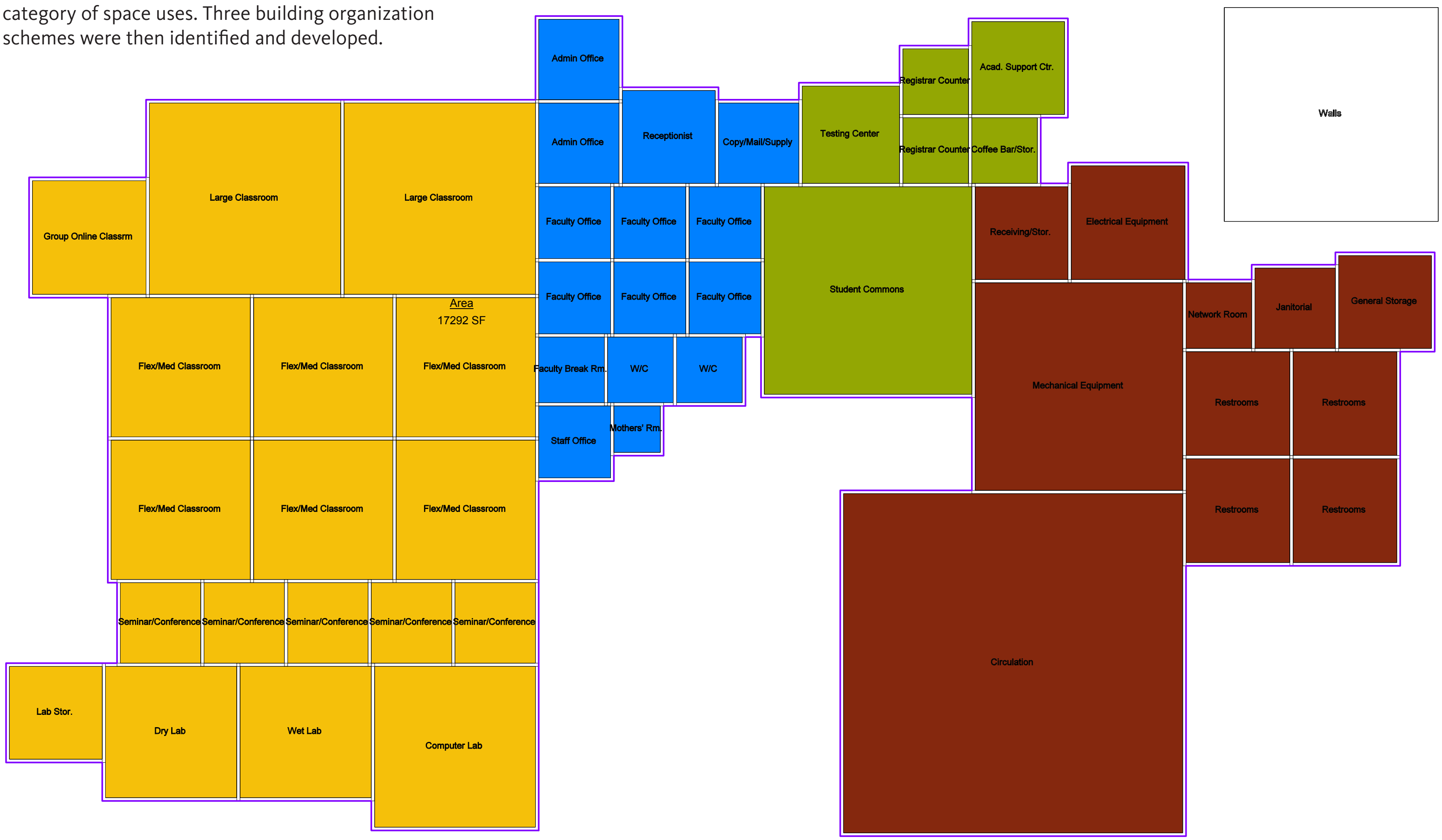
	Number	Unit	NSF	Occupants	Total Occ.	Cost/SF	Cost Estimate
Student Services							
Student Commons	1	1,000	1,000	35	35	$300.00	$300,000.00
Testing Center	1	220	220	10	10	$300.00	$66,000.00
Student Services						$300.00	$0.00
Registrar Counter	2	100	200	1	2	$300.00	$60,000.00
Academic Support Counter /Customer Service Office	1	200	200	1	1	$300.00	$60,000.00
Student Life						$300.00	$0.00
Coffee Bar and Storage	1	100	100			$300.00	$30,000.00
Subtotal - Student Support			1,720		48		**$516,000.00**

	Number	Unit	NSF	Occupants	Total Occ.	Cost/SF	Cost Estimate	Budget	Over
Building Support									
Loading Dock	1		-			$300.00	$0.00		
Receiving / Storage	1	200	200			$300.00	$60,000.00		
Mechanical Equipment	1	1,000	1,000			$300.00	$300,000.00		
Electrical Equipment	1	300	300			$300.00	$90,000.00		
Network Room	1	100	100			$300.00	$30,000.00		
Restrooms	4	250	1,000			$300.00	$300,000.00		
Janitorial Storage	1	150	150			$300.00	$45,000.00		
Circulation		1,344	1,344			$300.00	$403,200.00		
Walls		1,011	1,011			$300.00	$303,300.00		
General Building Storage	1	200	200			$300.00	$60,000.00		
Subtotal - Building Support			5,305				**$1,591,500.00**		
Summary									
Academic Areas			7,050		352		$2,195,000.00		
Administration and Faculty			1,840		24		$552,000.00		
Student Service and Life			1,720		48		$516,000.00		
Building Support			5,305		0		$1,591,500.00		
Total - Net Area / Occupant			15,915		424				
Net Assignable Sub-Total			15,915						
Net Assignable without Building Support			10,610						
Gross Efficiency			50%					**Budget**	**Over**
Gross Total			10,611				**$4,854,500.00**	**$4,800,000.00**	**$54,500.00**
									181.67
									sf to remove @$300/sf

identified in the following summary:

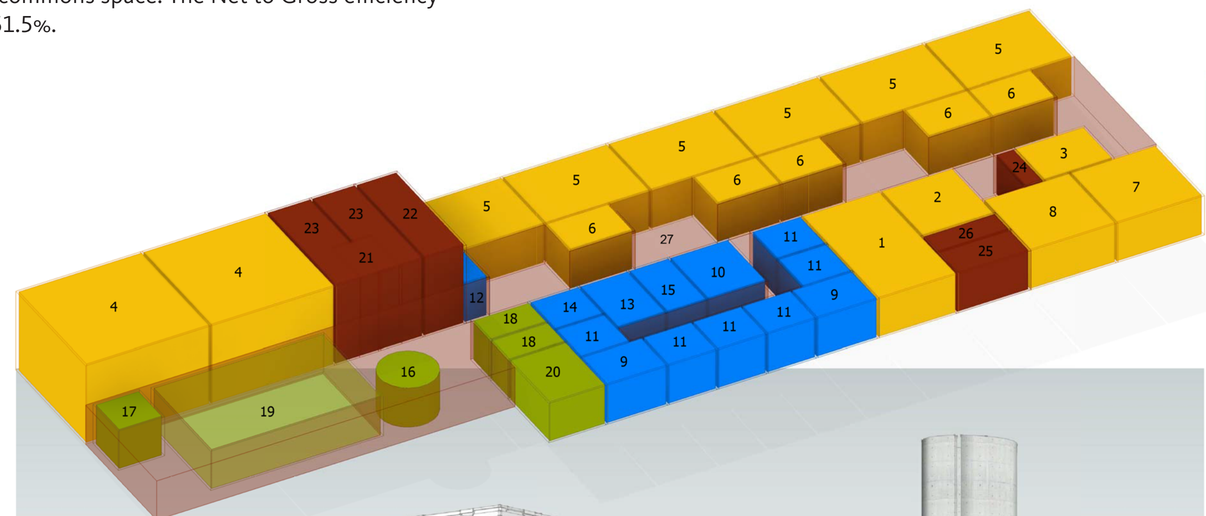
BUILDING ORGANIZATION OPTIONS

Initially the building program was visualized with the following diagram showing the relative size of each category of space uses. Three building organization schemes were then identified and developed.



BUILDING ORGANIZATION
OPTION 1 - ONE STORY

The first scheme is organized along a central, double loaded corridor and is all on one level. The large classrooms which combine to create a small conference space is located adjacent to the computer lab, and student commons space. The Net to Gross efficiency ratio is 61.5%.

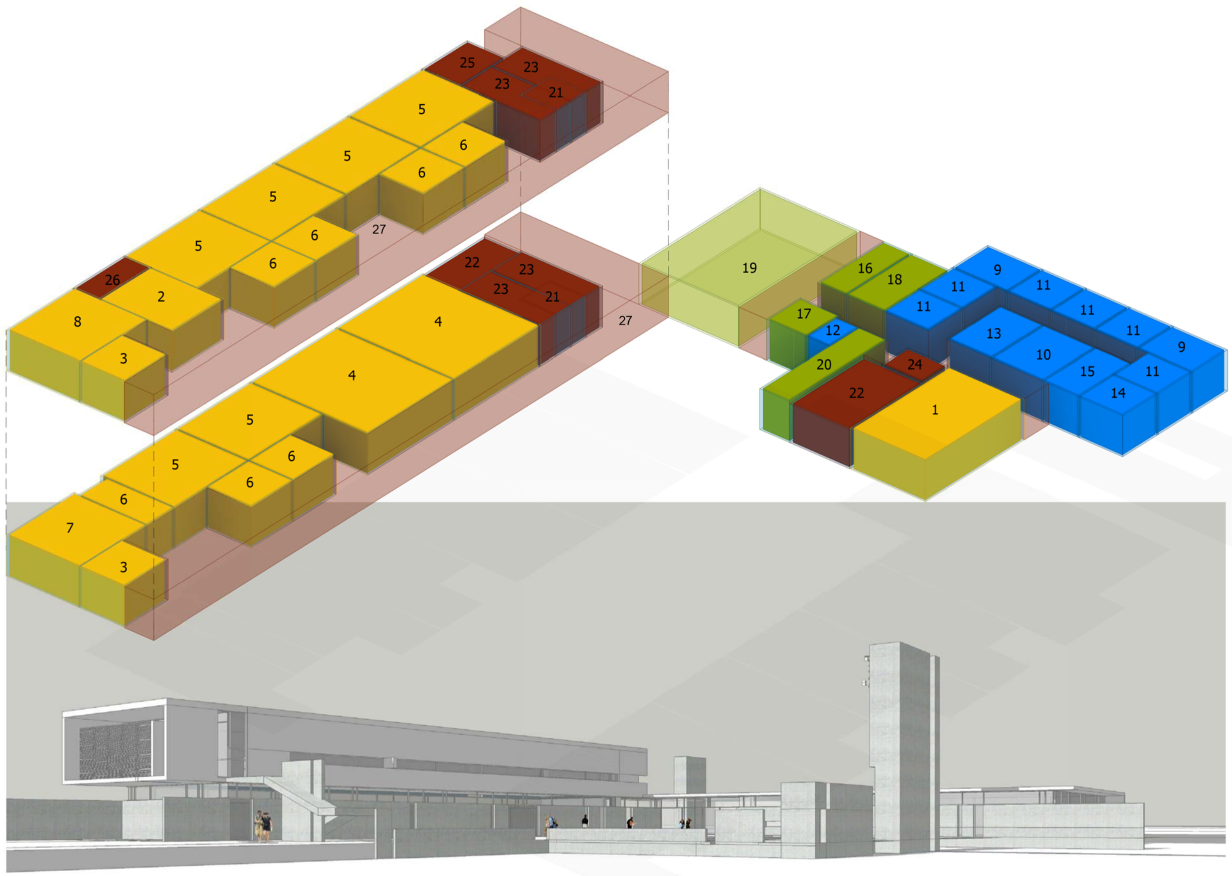


VIEW OF THE BUILDING LOOKING WEST

Scheme 1 (61.5% Efficient)					
Key	Space Name	#	Area	Cost/SF	Estimate
1-Academic Spaces					
1	Computer Lab	1	600 SF	$300	$180,000.00
2	Group Online Classrm	1	300 SF	$300	$90,000.00
3	Lab Stor.	1	200 SF	$300	$60,000.00
4	Large Classroom	2	1700 SF	$300	$510,000.00
5	Flex/Med Classroom	6	2700 SF	$300	$810,000.00
6	Seminar	5	750 SF	$300	$225,000.00
7	Wet Lab	1	400 SF	$400	$160,000.00
8	Dry Lab	1	400 SF	$400	$160,000.00
			7050 SF		$2,195,000.00
2-Administration & Faculty					
9	Admin Office	2	300 SF	$300	$90,000.00
10	Faculty Break Rm.	1	220 SF	$300	$66,000.00
11	Faculty Office	6	720 SF	$300	$216,000.00
12	Mothers	1	50 SF	$300	$15,000.00
13	Reception	1	182 SF	$300	$54,600.00
14	Staff Office	1	120 SF	$300	$36,000.00
15	Work	1	150 SF	$300	$45,000.00
			1742 SF		$522,600.00
3-Student Services					
16	Academic Support	1	140 SF	$300	$41,887.90
17	Coffee Bar/Stor.	1	100 SF	$300	$30,000.00
18	Registrar Counter	2	200 SF	$300	$60,000.00
19	Student Commons	1	1000 SF	$300	$300,000.00
20	Testing Center	1	220 SF	$300	$66,000.00
			1660 SF		$497,887.90
4-Building Support					
21	Janitorial	1	106 SF	$300	$31,800.00
22	Mechanical	1	270 SF	$300	$81,000.00
23	Restrooms	2	586 SF	$300	$175,800.00
24	Electrical	1	50 SF	$300	$15,000.00
25	General Storage	1	134 SF	$300	$40,200.00
26	Network Room	1	100 SF	$300	$30,000.00
27	Circulation	1	4491 SF	$300	$1,347,300.00
28	Walls	1	811 SF	$300	$243,300.00
			6548 SF		$1,964,400.00
Grand total: 46			17000 SF		$5,179,887.90

BUILDING ORGANIZATION
OPTION 2 - TWO STORY WITH A ONE STORY WING

The second scheme is split between a single and double story wing, with the academic wing and the faculty/administration wings being joined with a 'knuckle' comprising the main entry and the student commons and services. The two wings wrap around and embrace an exterior courtyard. The Net to Gross efficiency ratio is lowered to 52.8%, but the footprint is more compact.



VIEW OF THE BUILDING LOOKING WEST

Scheme 2 (52.8% Efficient)

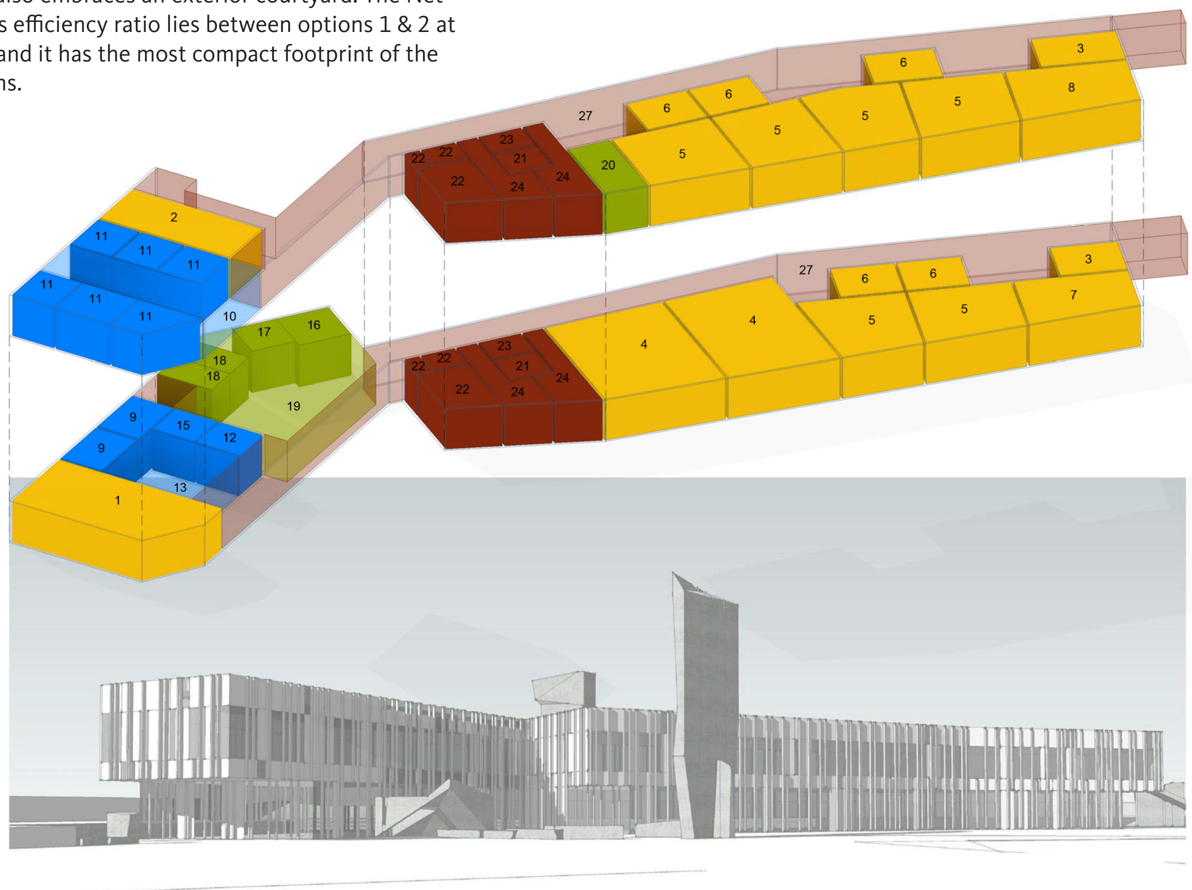
Key	Space Name	#	Area	Cost/SF	Estimate
1-Academic Spaces					
1	Computer Lab	1	600 SF	$300	$180,000.00
2	Group Online Classrm	1	300 SF	$300	$90,000.00
3	Lab Stor.	2	300 SF	$300	$90,000.00
4	Large Classroom	2	1700 SF	$300	$510,000.00
5	Flex/Med Classroom	6	2700 SF	$300	$810,000.00
6	Seminar	7	1050 SF	$300	$315,000.00
7	Wet Lab	1	400 SF	$400	$160,000.00
8	Dry Lab	1	400 SF	$400	$160,000.00
			7450 SF		$2,315,000.00
2-Administration & Faculty					
9	Admin Office	2	300 SF	$300	$90,000.00
10	Faculty Break Rm.	1	220 SF	$300	$66,000.00
11	Faculty Office	6	720 SF	$300	$216,000.00
12	Mothers	1	50 SF	$300	$15,000.00
13	Reception	1	182 SF	$300	$54,600.00
14	Staff Office	1	120 SF	$300	$36,000.00
15	Work	1	150 SF	$300	$45,000.00
			1742 SF		$522,600.00
3-Student Services					
16	Academic Support	1	140 SF	$300	$41,887.90
17	Coffee Bar/Stor.	1	100 SF	$300	$30,000.00
18	Registrar Counter	1	200 SF	$300	$60,000.00
19	Student Commons	1	1000 SF	$300	$300,000.00
20	Testing Center	1	220 SF	$300	$66,000.00
			1660 SF		$497,887.90
4-Building Support					
21	Janitorial	2	160 SF	$300	$48,000.00
22	Mechanical	2	535 SF	$300	$160,500.00
23	Restrooms	4	800 SF	$300	$240,000.00
24	Electrical	1	75 SF	$300	$22,500.00
25	General Storage	1	134 SF	$300	$40,200.00
26	Network Room	1	100 SF	$300	$30,000.00
27	Circulation	1	6429 SF	$300	$1,928,700.00
28	Walls	1	700 SF	$300	$210,000.00
			8933 SF		$2,679,900.00
Grand total: 52			19785 SF		$6,015,387.90

BUILDING ORGANIZATION
OPTION 3 - FULL TWO STORY

The third scheme is organized along a two-story, single loaded corridor, with the faculty/administration wing and the academic wing also being joined by the ‘knuckle of the two-story student commons. This option also embraces an exterior courtyard. The Net to Gross efficiency ratio lies between options 1 & 2 at 60.6%, and it has the most compact footprint of the 3 options.

FINAL SELECTION

Although aspects of all three options were found appealing, Scheme 3 was selected as the most satisfactory in terms of space use, minimal impact on the site, and aesthetic impact - it’s free lines and stratified design echoing the strata of the geologic formations that make Moab famous. However it was desired that the courtyard in Scheme 3 was to be developed to have some of the same characteristics as the one in Scheme 2.



VIEW OF THE BUILDING LOOKING WEST

Scheme 3 (60.6% Efficiency)					
Key	Space Name	#	Net Area	Cost/SF	Cost Estimate
1-Academic Spaces					
1	Computer Lab	1	704 SF	$300	$211,340
2	Group Online Classroom	1	422 SF	$300	$126,560
3	Lab Storage	2	370 SF	$300	$111,087
4	Large Classroom	2	1702 SF	$300	$510,715
5	Medium Classroom	6	2685 SF	$300	$805,617
6	Seminar	5	790 SF	$300	$237,012
7	Wet Lab	1	384 SF	$400	$153,770
8	Dry Lab	1	457 SF	$400	$182,651
		19	7515 SF		$2,338,754
2-Administration & Faculty					
9	Admin Office	2	288 SF	$300	$86,275
10	Faculty Break Room	1	536 SF	$300	$160,650
11	Faculty Office	6	729 SF	$300	$218,765
12	Mothers	1	97 SF	$300	$28,975
13	Reception/ Work	1	406 SF	$300	$121,875
15	Staff Office	1	97 SF	$300	$28,975
		12	2152 SF		$645,515
3-Student Services					
16	Academic Support	1	140 SF	$300	$41,888
17	Coffee Bar	1	100 SF	$300	$30,000
18	Registrar Counter	2	200 SF	$300	$60,000
19	Student Commons	1	1012 SF	$300	$303,578
20	Testing	1	186 SF	$300	$55,828
		6	1638 SF		$491,294
4-Building Support					
21	Janitorial	2	159 SF	$300	$47,737
22	Mechanical	6	503 SF	$300	$150,871
23	Electrical	2	143 SF	$300	$42,750
24	Restroom	4	730 SF	$300	$219,103
27	Circulation	2	4488 SF	$300	$1,346,533
28	Walls	1	1116 SF	$300	$334,668
		17	7139 SF		$2,141,663
Grand total		54	18444 SF		$5,617,226

O5.

SUSTAINABILITY REQUIREMENTS & GOALS

INTRODUCTION

During the Community Workshop, the project's stakeholders and designers discussed what it means to have a comprehensive approach to creating a sustainable building and setting the tone for a sustainable campus. The importance of building on common ground within the community and finding things that everyone in the community could get behind was identified as an important task. The community identified a set of goals that could take advantage of Moab's unique opportunities and tackle some of its biggest challenges, thus being an example of how community members can address similar issues in the built environment. On top of the goals identified by the community, there are also certain requirements that have to be met. The state of Utah requires that all public construction projects comply with the DFCM Design Requirements, including the High Performance Building Standard . The project must also meet the Utah State University sustainability goals. The sustainability requirements for the project are as follows:

- Achieve LEED Gold Certification as a minimum goal, achieving Gold or higher working with the budget allowance and evaluating the cost to benefit ratio.
- Achieve the following credits in the LEED rating system
  - WE Credit 1.1: Water Efficient Landscaping: Reduce by 50%
  - EA Credit 3 Enhanced Commissioning
  - EQ Credit 3.1 Construction IAQ Management Plan: During Construction
  - EQ Credit 4.1: Low-Emitting Materials: Adhesives and Sealants
  - EQ Credit 4.2: Low-Emitting Materials: Paints and Coatings
- Complete an energy model to demonstrate the building design performance relative to a code compliant building.
- Model building systems to analyze and make selection based on life-cycle cost.
- Include meters and sub-meters in the building to measure energy consumption on an on-going basis.
- Document Sustainability Charrette Summary, Life Cycle Cost Analysis, LEED submittals and Submittal Comments, Commissioning Report, and the Energy Analysis to comply with High Performance Building Requirements.

In addition to the requirements above, the USU Moab Phase 1 Building team has set several sustainability goals. These goals reflect the most important environmental issues for the climate of Utah generally and the climate of the Moab area in particular.

- Reduce energy cost by at least 20% compared to a code-compliant building, more if found effective from a life-cycle standpoint
- Achieve the goal of 'Net-zero' water for landscaping use. Harnessing captured rain water only for landscape irrigation.
- Enhance human experience of building, especially access to daylight.
- Design for durability & long building life.
- Contribute to the success of Utah State University's Climate Action Plan.

One of the most prescient goals identified in the course of the feasibility study, which it was felt that the entire community could rally around was net zero water for landscaping. As a part of a means to accomplishing this goal, as well as developing a plan that was comprehensive in its approach to integrating the various sustainable strategies, it was determined to conduct a Permaculture Analysis as part of the feasibility Study. The existing USU Moab facility has recently employed Permaculture gardens and rainwater harvesting techniques to great utility in building excitement within the city and demonstrating to residents how to reduce water use for edible landscaping. The implementation of the Permaculture analysis is also a step towards the integrated Design Process outlined in the DFCM's High Performance Building Standard.

USU CLIMATE ACTION PLAN

In 2007 Utah State University signed the President's Climate Commitment, joining the nationwide movement to reduce global warming by achieving climate neutrality. This subsequently led in 2010 to the issuance of the USU Sustainability Policy & the USU Climate Action Plan. These strategies include the goal of achieving climate neutrality by 2050, which was more aggressive than the State of Utah's goal of a 20% reduction in energy use by 2020. USU's Goals for achieving climate neutrality will be achieved by:

- Reducing campus energy consumption
- Obtaining energy from renewable and sustainable sources
- Institutionalizing sustainable culture in students, faculty and staff
- As a last resort by purchasing carbon offsets.

HIGH PERFORMANCE BUILDING STANDARD

During the process of this feasibility study, the current State energy design standards administered by the DFCM were revised. A summary of the current requirements follows. Although certification through LEED, and achievement of a Silver certification is no longer required, the requirements listed outline similar stipulations. (It should be noted that although DFCM no longer requires Silver Certification, Utah State University still does as the minimum level of certification.)

INTEGRATED DESIGN PROCESS

The DFCM outlines a series of requirements and suggested practices which allow for a maximization of value in incorporating the HPBS standards into the design by creating an interdisciplinary team from the beginning of the programming phase. This includes the hiring of an energy engineer and commissioning agents, holding comprehensive HPBS workshops at the beginning of every phase of design ensuring that sustainability, energy, systems, envelope and site strategies get addressed. Site plans, BOD's, and OPR's would be updated with submittals for each phase of design, bidding, construction, and completion (with specific requirements for each) and be reviewed by the owner, energy engineer and commissioning agents.

CONTEXT-SENSITIVE DESIGN

In addition to the building's siting needing to reflect a sensitive relationship to the sun - with optimal access to it and shading from it - the design needs to reflect an awareness of local land-use and master planning, open space, trail and recreation planning, local & regional storm water planning, applicable environmental regulations, community vision and development patterns, and vernacular design. The design needs to demonstrate enhances access for pedestrians and transit, such as protected paths and landscaped barriers.

TRANSPORTATION MANAGEMENT & ADAPTATION

Goals for reducing single rider vehicle impacts, and encouraging transit ridership and carpooling beyond municipal requirements need to be set and included in the OPR. Clear, safe paths for pedestrians and cyclists, with showering and bicycle storage facilities need to be defined.

SITE DESIGN

An open space plan is to be developed, including pedestrian paths and recreation areas, limited turf, aesthetic and native landscaping, emergency use landscaping, and how these integrate with transportation management. The plan needs to comply with EPA Watersense, Storm Water best management practices, reduced heat island effect and light pollution.

FACILITY ENERGY PERFORMANCE

In addition to mandatory requirements for new construction and equipment, energy performance must be improved beyond code compliance in concert with life-cycle analysis. The target improvement is for a 20% improvement over the ASHRAE Standard 90.1-2010 where that improvement is life-cycle cost effective. Where it is not life cycle-cost-effective, the highest improvement that is determined to be life-cycle cost effective will be used.

WATER EFFICIENCY

Plumbing fixtures and appliances must meet EPA Watersense requirements and once-through process water systems are disallowed.

MATERIALS & RESOURCES

Water bottle filling stations and recycling facilities and programs are required. Additionally 35% of the materials in the project by value are required to meet requirements for regional or recycled materials.

INDOOR ENVIRONMENTAL QUALITY

The HPBS outlines requirements for improving indoor air quality during construction and pre-occupancy, stipulates compliance for al paints, coatings, adhesives, sealants, and flooring systems with low-emitting criteria. Entryway systems or walk-off matts are required, as well as pollution point source mitigation such as exhausting janitorial closets and print-rooms. Task lighting will be provided for all work-spaces, 65% of occupied spaces will be afforded daylighting and views.

EDUCATION & OUTREACH

Strategies for communicating the sustainable features of the building outlined above to building occupants need to be defined & employed, and Energy Star Tracking will be implemented.

METERING AND DATA POINTS

All utilities connected to the building need to be equipped with metering and at times sub-metering equipment, allowing energy use to be monitored, tracked and reported.

COMMISSIONING OF SYSTEMS & ENVELOPE

The commissioning agents hired at the beginning of the project will review the design, execution, installation, and performance of all building mechanical and electrical systems as well as systems for controlling air, water, moisture, and vapor infiltration in the envelope for the building.

INCENTIVES & REBATES

All available incentives and rebates pursuant to any of the above or of other building performance related measures shall be pursued by the project design team.

FIGURE 9.1.14 PROPOSED LEED CHECKLIST

LEED 2009 for New Construction and Major Renovations

Project Checklist

Project Name

Date

Sustainable Sites — Possible Points: 26

Y	?	N			
9	3	2	**Sustainable Sites**		**Possible Points: 26**
Y			Prereq 1	Construction Activity Pollution Prevention	
1			Credit 1	Site Selection	1
		1	Credit 2	Development Density and Community Connectivity	5
		1	Credit 3	Brownfield Redevelopment	1
	1		Credit 4.1	Alternative Transportation—Public Transportation Access	6
1			Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
1			Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
1			Credit 4.4	Alternative Transportation—Parking Capacity	2
1			Credit 5.1	Site Development—Protect or Restore Habitat	1
1			Credit 5.2	Site Development—Maximize Open Space	1
1			Credit 6.1	Stormwater Design—Quantity Control	1
1			Credit 6.2	Stormwater Design—Quality Control	1
1			Credit 7.1	Heat Island Effect—Non-roof	1
	1		Credit 7.2	Heat Island Effect—Roof	1
	1		Credit 8	Light Pollution Reduction	1

Water Efficiency — Possible Points: 10

Y	?	N			
9	1		**Water Efficiency**		**Possible Points: 10**
Y			Prereq 1	Water Use Reduction—20% Reduction	
4			Credit 1	Water Efficient Landscaping	2 to 4
2			Credit 2	Innovative Wastewater Technologies	2
3	1		Credit 3	Water Use Reduction	2 to 4

Energy and Atmosphere — Possible Points: 35

Y	?	N			
20	13		**Energy and Atmosphere**		**Possible Points: 35**
Y			Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			Prereq 2	Minimum Energy Performance	
Y			Prereq 3	Fundamental Refrigerant Management	
9	10		Credit 1	Optimize Energy Performance	1 to 19
7			Credit 2	On-Site Renewable Energy	1 to 7
2			Credit 3	Enhanced Commissioning	2
1			Credit 4	Enhanced Refrigerant Management	2
1	1		Credit 5	Measurement and Verification	3
	2		Credit 6	Green Power	2

Materials and Resources — Possible Points: 14

Y	?	N			
5	6	3	**Materials and Resources**		**Possible Points: 14**
Y			Prereq 1	Storage and Collection of Recyclables	
		2	Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
		1	Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements	1
1	1		Credit 2	Construction Waste Management	1 to 2
1	1		Credit 3	Materials Reuse	1 to 2

Materials and Resources, Continued

Y	?	N			
1	1		Credit 4	Recycled Content	1 to 2
1	1		Credit 5	Regional Materials	1 to 2
1	1		Credit 6	Rapidly Renewable Materials	1
	1		Credit 7	Certified Wood	1

Indoor Environmental Quality — Possible Points: 15

Y	?	N			
13	2		**Indoor Environmental Quality**		**Possible Points: 15**
Y			Prereq 1	Minimum Indoor Air Quality Performance	
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
	1		Credit 1	Outdoor Air Delivery Monitoring	1
1			Credit 2	Increased Ventilation	1
1			Credit 3.1	Construction IAQ Management Plan—During Construction	1
1			Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
1			Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
1			Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
1			Credit 4.3	Low-Emitting Materials—Flooring Systems	1
1			Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
1			Credit 5	Indoor Chemical and Pollutant Source Control	1
1			Credit 6.1	Controllability of Systems—Lighting	1
1			Credit 6.2	Controllability of Systems—Thermal Comfort	1
1			Credit 7.1	Thermal Comfort—Design	1
1			Credit 7.2	Thermal Comfort—Verification	1
	1		Credit 8.1	Daylight and Views—Daylight	1
1			Credit 8.2	Daylight and Views—Views	1

Innovation and Design Process — Possible Points: 6

Y	?	N			
4	2		**Innovation and Design Process**		**Possible Points: 6**
1			Credit 1.1	Innovation in Design: Specific Title	1
1			Credit 1.2	Innovation in Design: Specific Title	1
1			Credit 1.3	Innovation in Design: Specific Title	1
	1		Credit 1.4	Innovation in Design: Specific Title	1
	1		Credit 1.5	Innovation in Design: Specific Title	1
1			Credit 2	LEED Accredited Professional	1

Regional Priority Credits — Possible Points: 4

Y	?	N			
4			**Regional Priority Credits**		**Possible Points: 4**
1			Credit 1.1	Regional Priority: Specific Credit	1
1			Credit 1.2	Regional Priority: Specific Credit	1
1			Credit 1.3	Regional Priority: Specific Credit	1
1			Credit 1.4	Regional Priority: Specific Credit	1

Total — Possible Points: 110

Y	?	N		
64	27	5	**Total**	**Possible Points: 110**

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110

ENERGY MODELING

In addition to building information modeling to assess the space efficiency functionality and aesthetics of design options, energy modeling was used from the beginning to ensure that the infrastructure proposed makes the best use of on-site assets and energies, capitalizing on them from the beginning, and capturing cost savings where possible.

LEED CHECKLIST

Exceeding the requirements of Utah State University, the USU Moab Phase One Building is targeting LEED Gold. Several of the features which were integrated into the project contribute to its achieving this goal, namely the innovative water use reduction strategies, the energy model which incorporates passive solar heating, passive cooling, geothermal heat pumps and solar photovoltaic panels to assist in the running of the pumps. A preliminary scorecard shows that LEED Gold is more than an achievable goal with 64 points estimated.

PERMACULTURE ANALYSIS

During the community workshop, in addition to Utah State's High Performance Building Standard, USU's Climate Action Plan, and the LEED certification program, other frameworks were considered for evaluating a comprehensive and innovative approach to what is possible to achieve with building performance. One of these programs was the Living Building Challenge and the other was Permaculture Design. Both are similar in that they push the envelope of what is considered standard practice for construction industry, encouraging a rethinking of how things might be done to bring a building into balance with its immediate and global environs. After reviewing the Living Building Challenge, it was recognized that some of the imperatives would not be achievable in Moab's climate, namely the net-zero water imperative that stipulates for all water to be used in the building from faucets to irrigation to be captured from its roof. With but 9 inches of rain captured per year on its roof, this would be an impossible task for any building in Moab. The discussion did however inspire a goal, to achieve net-zero water for the irrigation of the landscape - that all water used for plantings surrounding the building be harvested, and captured from the site itself. Because USU had embarked on a similar project with its 'Bee-Inspired' gardens and with its new rainwater harvesting garden at its downtown Moab campus, using Permaculture Design to set up the necessary systems, it was determined to use a similar approach for the USU Moab Phase One Building. The following section describes how permaculture was influential in integrating sustainability into the project and the building into the landscape, and section 7 includes the full permaculture report.

APPLICABLE CODES/ STANDARDS/REGULATIONS

- 2012 International Building Code (IBC)
- 2012 International Fire Code (IFC)
- 2012 International Plumbing Code (IPC)
- 2012 International Mechanical Code (IMC)
- 2011 National Electrical Code (NEC)
- 2012 International Energy Conservation Code (IECC)
- 2009 ANSI/A117.1
- 2012 International Plumbing Code (IPC)
- 2012 International Fuel Gas Code (IFGC)
- LEED 2009 (v3)
- DFCM High Performance Building Standard 7-2-2014
- ASHRAE 90.1-2010

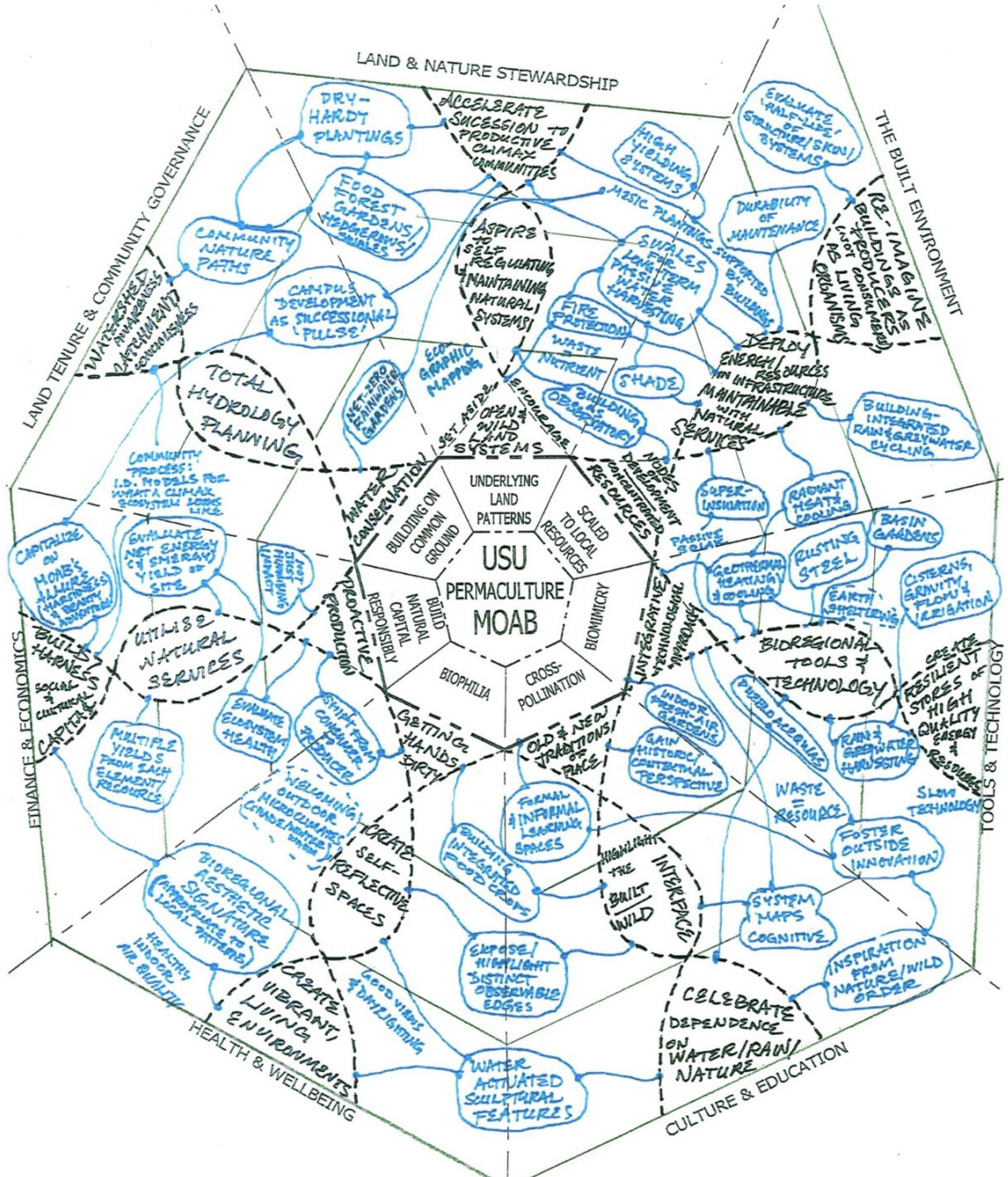
06.

DESIGN PROCESS & FEATURES

Land & Nature Stewardship
Land Tenure & Community Governance
Finance & Economics
Health & Wellbeing
Culture & Education
Tools & Technology
The Built Environment

INTRODUCTION

Throughout the feasibility study process, the design team took an integrated design process approach. During the community workshop, a means of building on common ground within the community around sustainability and the conservation of resources was permaculture design, which had been used effectively by USU in Moab in their 'Bee Inspired' community garden and in their rainwater harvesting garden. The design team developed a permaculture framework to bring the analysis of the master plan, the needs of USU Moab, and the feedback received together. This allowed for the identification of all of the criteria that the project needed to meet and created a space for how the project might incorporate novel solutions to integrate the building needs into a functioning whole. The framework identifies the seven sectors of influence seen below where permaculture design principles and innovations can be implemented to rethink conventional approaches to design and construction (see the section 7. Permaculture Report).



PERMACULTURE BUILDING MAP

The diagram above was the first step in visualizing the building as an organism that by its nature met the building needs. All of the important functions were listed in the appropriate sector of the diagram, and opportunities for integration, collaboration and overlap were looked for. This subsequently developed into the comprehensive building map seen opposite.

This framework guided the decision making process during the evaluation of different design and system options, attempting to see how well they would work (or not work) in concert.

LAND AND NATURE STEWARDSHIP

OPEN SPACE

The Master plan for the USU Moab Campus provides the framework for an optimal approach to making natural, open space available to the community. The buildings on the campus are clustered around designed and programmed landscaping, leaving the majority of the 40 acre site as preserved open space which can be preserved in its current state and improved to represent a native climax ecosystem over time. The phasing plan for the campus consists of 'pods' developed successively. With the selection of the Northeast-most pod as the site for the first building as opposed to the south-most pod the phasing will now likely proceed from the North to the South. The site plan below shows a gradient of shade that is built into the campus, being more diffuse in the parking and building in density as one approaches the entry to the building, creating a sense of pleasant habitability in what can be a hot and harsh environment.

COURTYARDS

To set the tone, or theme of the campus, as one of academic 'villages' clustered around commons spaces, one of the important aspects of the design option chosen for development was the courtyard space. This space, framed by the two wings of the building and the sculptural monument, provides a welcoming entry for the visitor to the campus as well as a space for students, faculty and staff to congregate and experience the landscape. The sculptural monument reflects the rock formations and topography of the site, which has been sculpted through centuries of engagement with the elements. A small courtyard space was also integrated on the south side of the building in response to the desires expressed in the community workshop for both a warm south-facing outdoor space. A space that could both capitalize on Moab's mild winters for outdoor teaching and that could work with the ground level of the building be a 'garden level' that is semi recessed into the site, taking advantage of the cool temperatures of the ground in the summer and giving occupants a close proximity to the landscape.

SITE PLAN

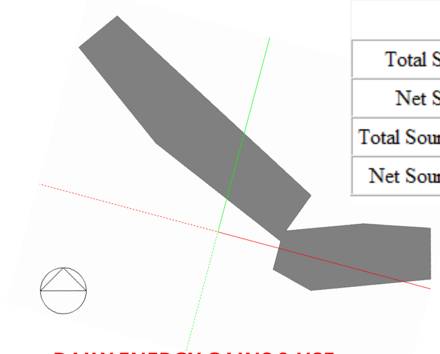
PHASING PLAN

SITING

Several placements of the building were investigated on the site with regard to how the building form engaged the approach to campus and its topography, and how the sun and the windows affected the cooling load of the building. How well the options worked for partially recessing the building into the slope of the site, were also assessed.

The four orientations investigated had similar estimated cooling loads based on the generic 25% glazing, code compliant model used. These estimated cooling loads can be seen in the blue bars in the annual energy gain & use graphs to the right.

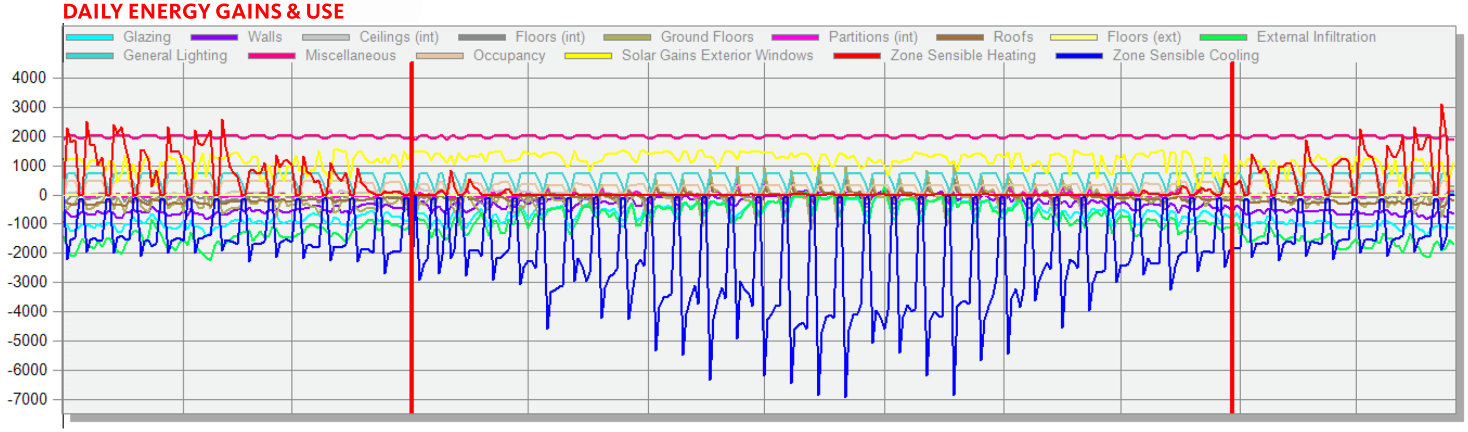
ROTATED 15° EAST



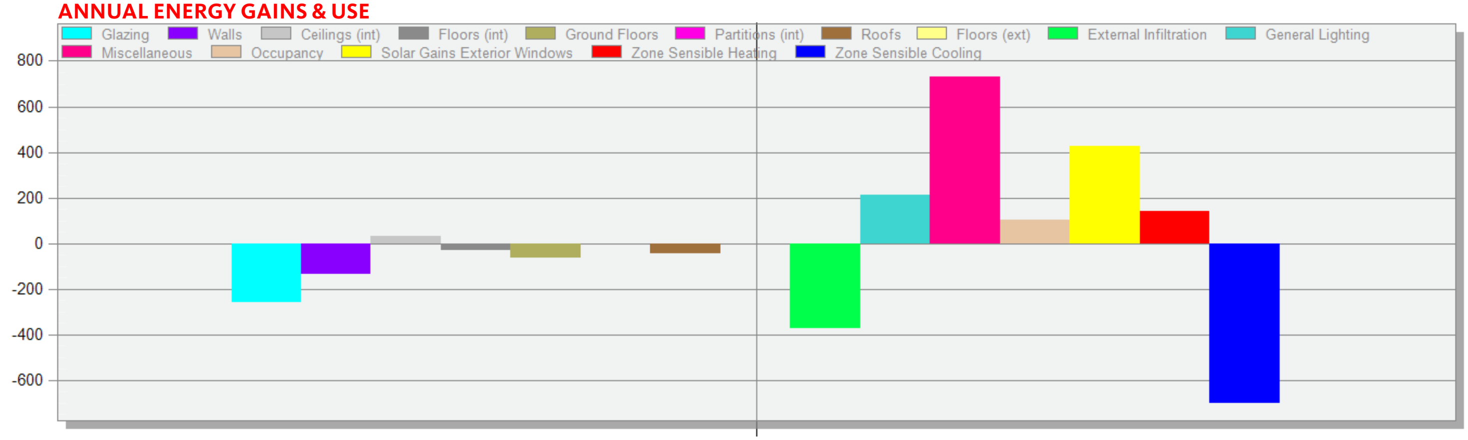
SITE & SOURCE ENERGY

	Total Energy [kBtu]	Energy Per Total Building Area [kBtu/ft2]	Energy Per Conditioned Building Area [kBtu/ft2]
Total Site Energy	1779858.84	112.64	112.64
Net Site Energy	1779858.84	112.64	112.64
Total Source Energy	4360783.25	275.97	275.97
Net Source Energy	4360783.25	275.97	275.97

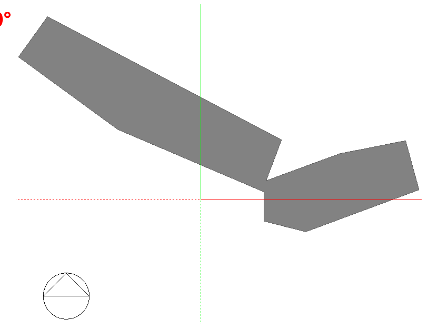
DAILY ENERGY GAINS & USE



ANNUAL ENERGY GAINS & USE



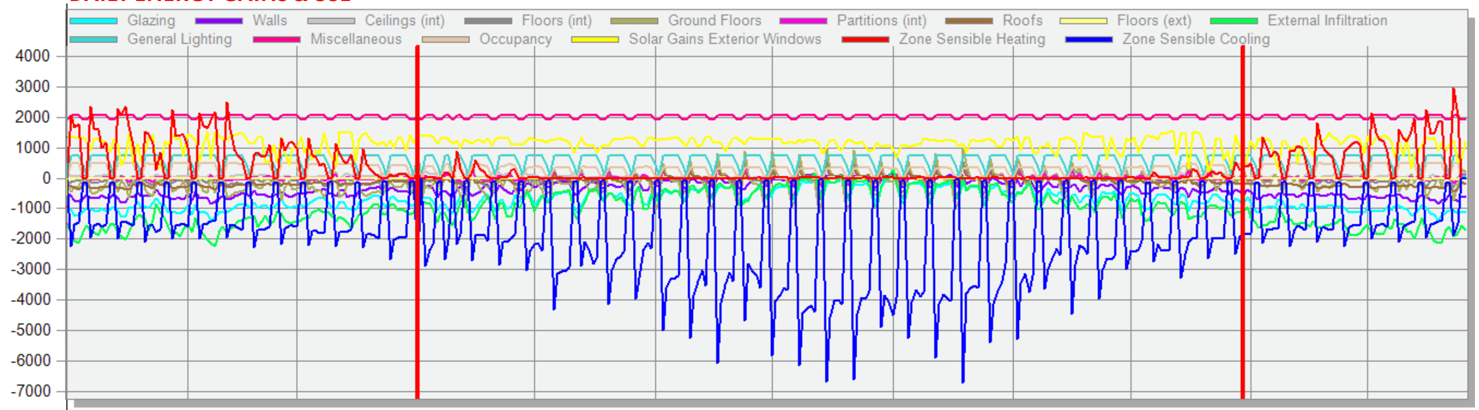
ROTATED 0°



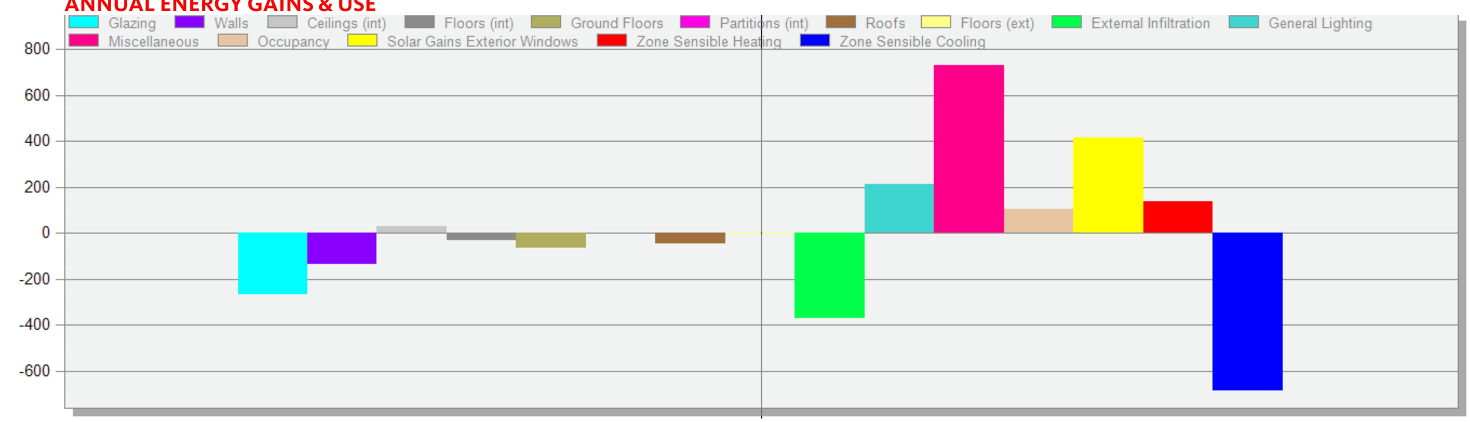
SITE & SOURCE ENERGY

	Total Energy [kBtu]	Energy Per Total Building Area [kBtu/ft2]	Energy Per Conditioned Building Area [kBtu/ft2]
Total Site Energy	1759954.54	111.38	111.38
Net Site Energy	1759954.54	111.38	111.38
Total Source Energy	4327826.25	273.88	273.88
Net Source Energy	4327826.25	273.88	273.88

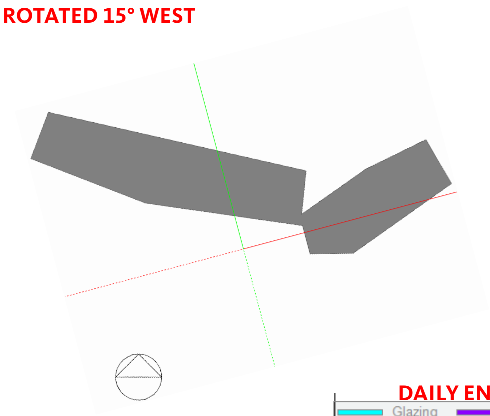
DAILY ENERGY GAINS & USE



ANNUAL ENERGY GAINS & USE



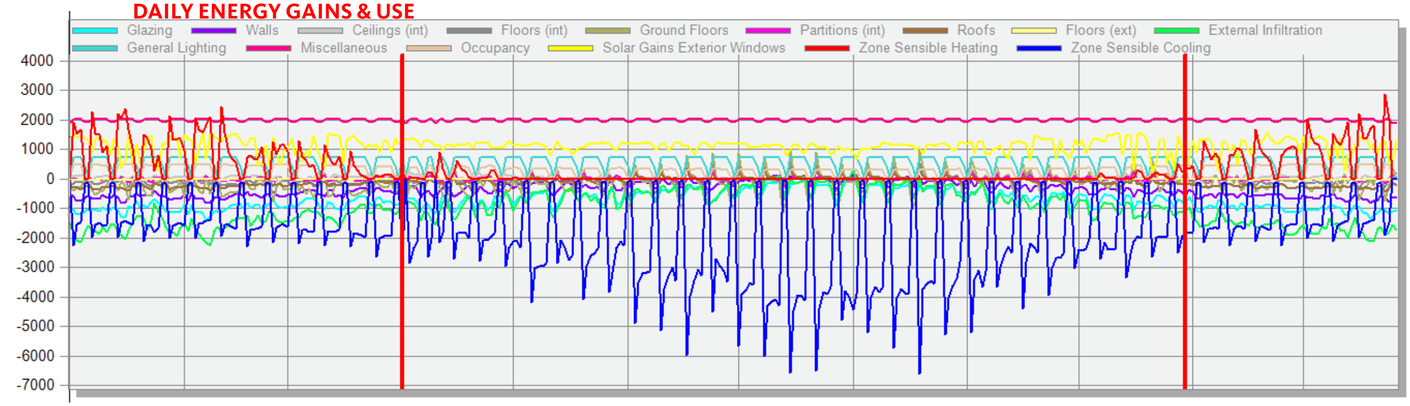
ROTATED 15° WEST



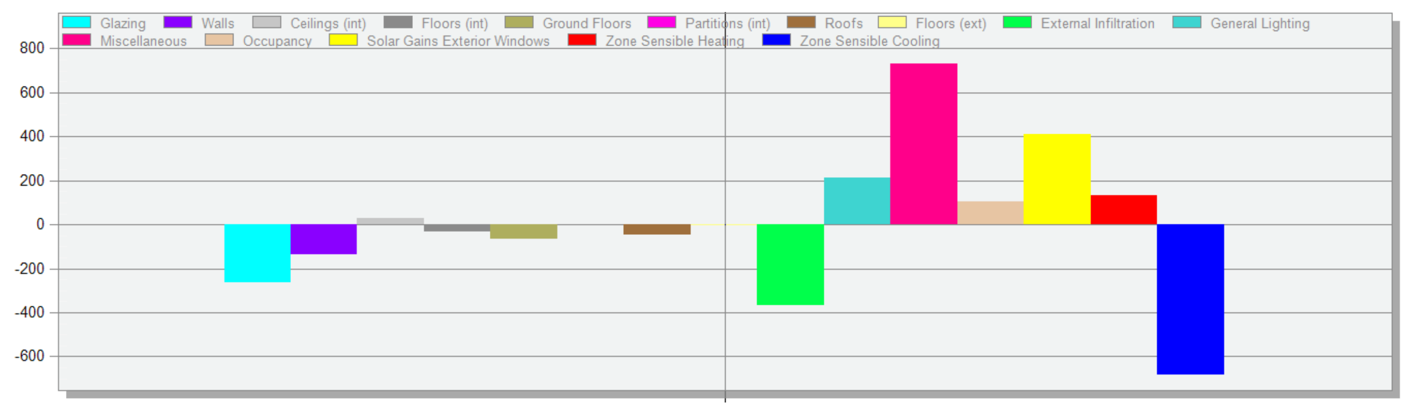
SITE & SOURCE ENERGY

	Total Energy [kBtu]	Energy Per Total Building Area [kBtu/ft2]	Energy Per Conditioned Building Area [kBtu/ft2]
Total Site Energy	1749975.73	110.75	110.75
Net Site Energy	1749975.73	110.75	110.75
Total Source Energy	4307452.15	272.59	272.59
Net Source Energy	4307452.15	272.59	272.59

DAILY ENERGY GAINS & USE

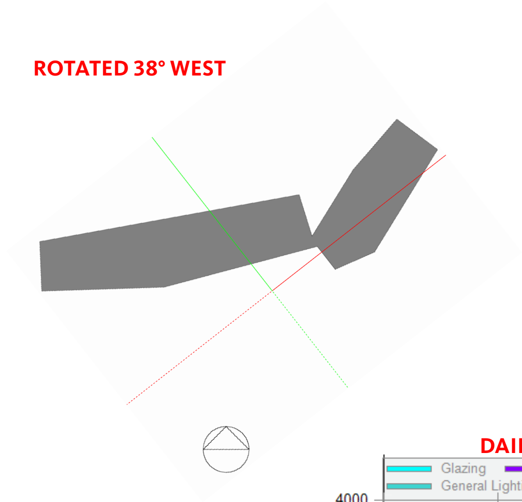


ANNUAL ENERGY GAINS & USE



SITING & ENERGY ANALYSES

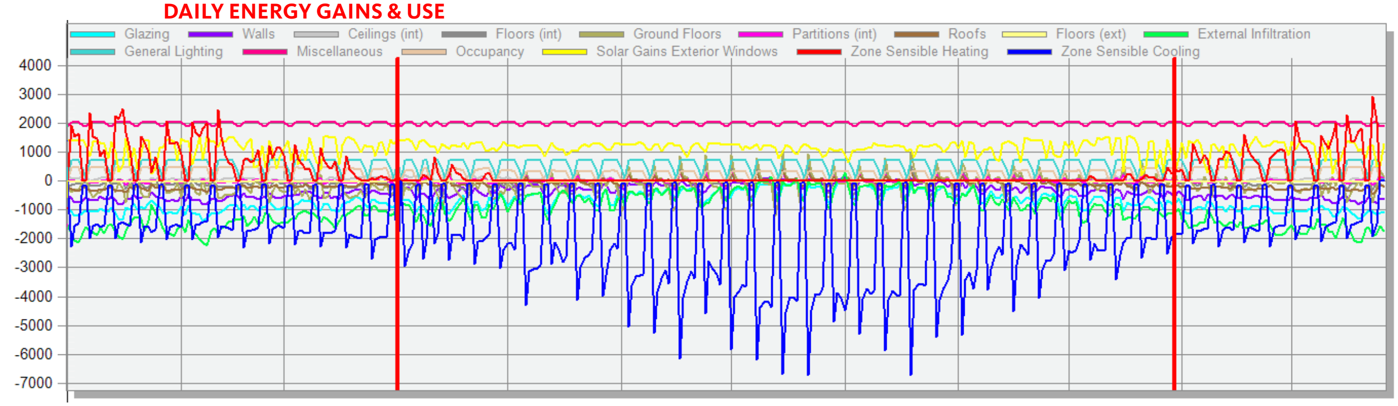
ROTATED 38° WEST



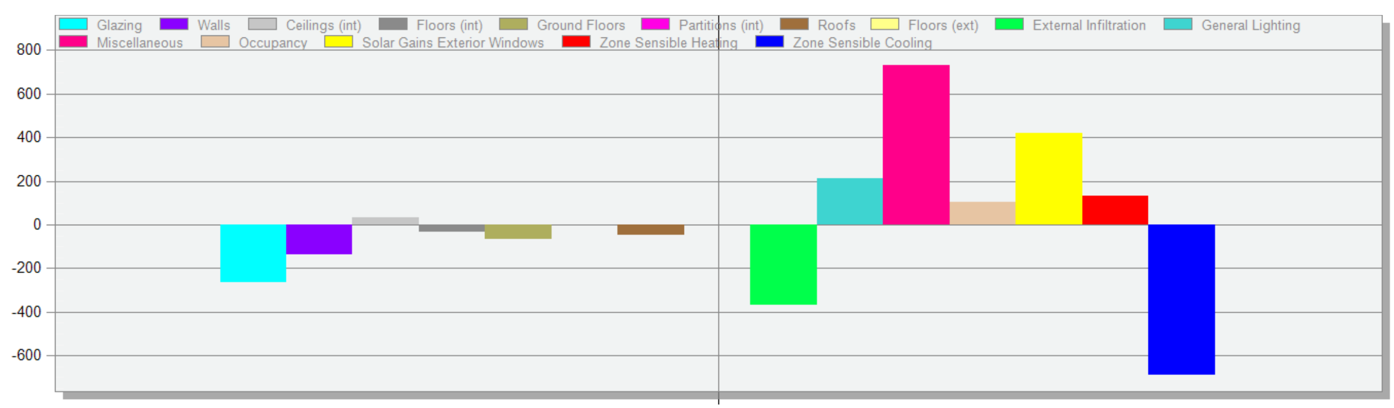
SITE & SOURCE ENERGY

	Total Energy [kBtu]	Energy Per Total Building Area [kBtu/ft2]	Energy Per Conditioned Building Area [kBtu/ft2]
Total Site Energy	1759896.10	111.37	111.37
Net Site Energy	1759896.10	111.37	111.37
Total Source Energy	4316163.33	273.15	273.15
Net Source Energy	4316163.33	273.15	273.15

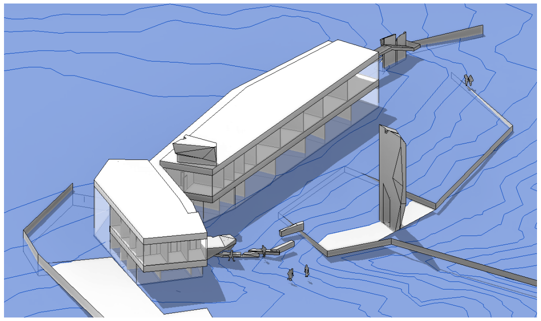
DAILY ENERGY GAINS & USE



ANNUAL ENERGY GAINS & USE

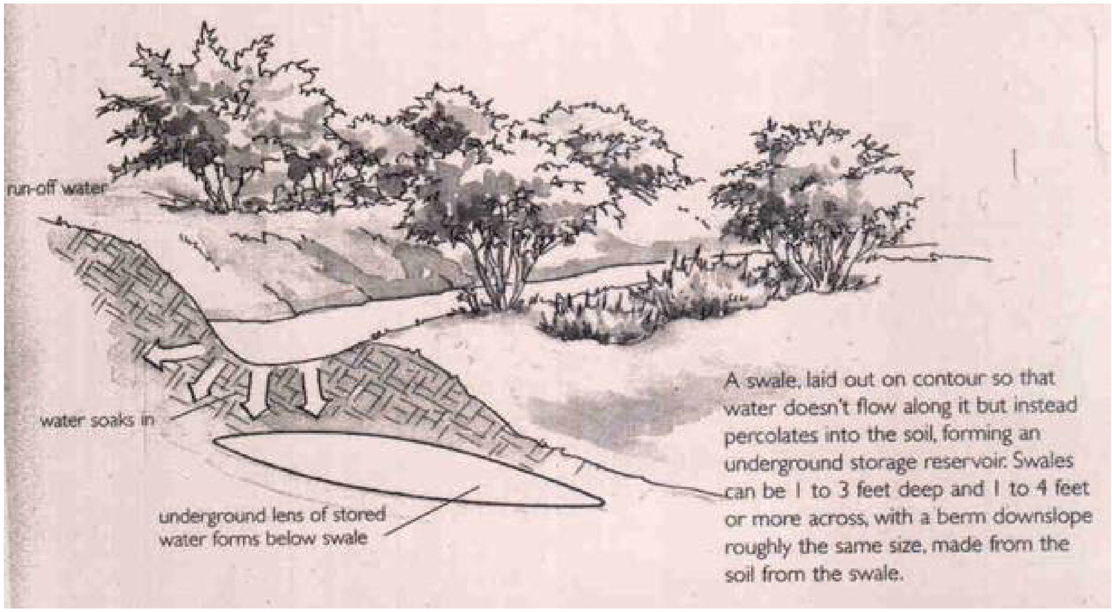


SITING & TOPOGRAPHY



The orientation chosen was the one in which it was the easiest to recess the building into the grade whilst simultaneously embracing a courtyard between the building and the road. The selected orientation follows the contours of the land and allows the footpaths on the site to tie into the courtyards & entrances.

SWALE



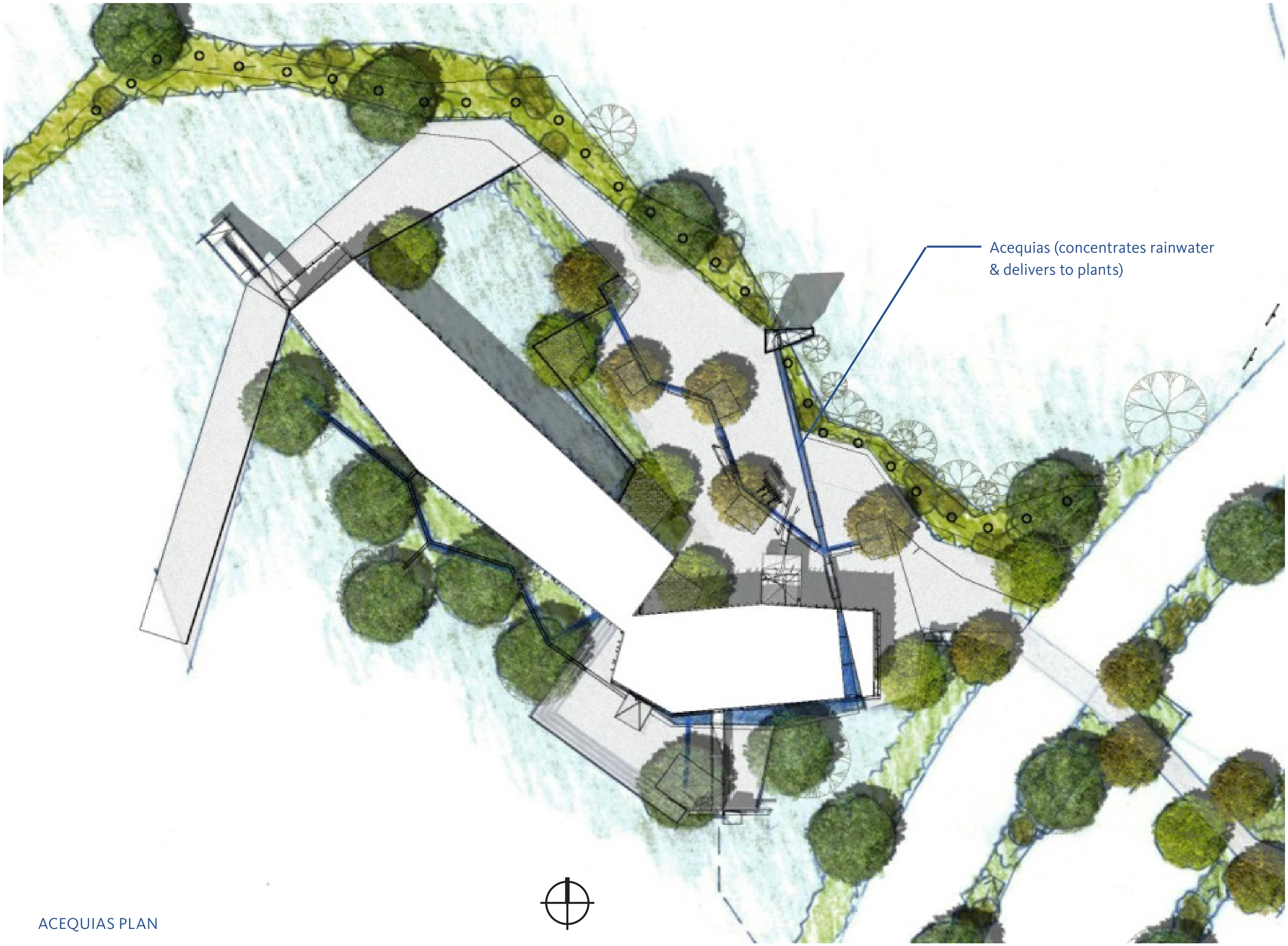
SWALE DIAGRAM - TOBY HEMENWAY

SWALE EARTHWORKS

The site plan also shows what in Permaculture Design is termed a swale, or a water harvesting channel on contour, just to the North and down-slope of the building. This swale is a storm water management strategy which simultaneously fulfills multiple functions on the site. First it stops storm water runoff in place, preventing erosion and allowing moisture to soak into the ground. Over time, this creates a built-up 'lens' of water held in hydrostatic tension, providing a water storage to help trees weather droughts. Because it also acts as a 'wet-line' in the landscape and is downhill of the building, it acts a fire protection from the predominant zone of fire danger (as a wild fire in this location would likely move its way uphill). Swales easily double as paths, to be used when they are not full of water, or raised areas can be provided adjacent to the water infiltration space so that they can be used even when full of water. In the plan it has been placed to tie the courtyard and the sculptural monument to the network of paths and trails that connect the campus to the community and to the wilderness. The dryland plantings outlined in the permaculture report for the swale consist of what is called a 'food forest'. Designed to subsist solely on rainwater, this plant community mimics the ecological structure and layering of a mature woodland, but is stacked with species which have a high human food value. Utilizing predominantly native species, many of ethnobotanical use, it provides visitors to the facility with the opportunity to connect with the landscape and with plant communities that have historically been very important to it and to the peoples inhabiting it. Because the swale would require earthwork, it also doubles as a well field for the geothermal energy system (shown as circles spaced about every 15 feet drawn in the swale pathway in landscaping plan opposite. As well fields are typically laid out in grids of about 15' on center each way, a linear field would potentially improve the efficacy of the individual bore holes because they can heat and cool farther out to either side.

MESIC FOREST GARDENS

Also visible in the landscaping plan are the trees shown with a warmer, reddish hue indicating edible trees which require more of a wet, mesic environment. Using the built infrastructure of the building, its rainwater harvesting cistern, its grey water, and surrounding hardscape to concentrate rainfall and deliver it to these plantings draws on the traditional



ACEQUIAS PLAN

puebloan strategies of using infrastructure such as acequias (as in figure as shown in the acequias plan), or stone water conveyance ditches, to create pockets of more habitable environments in a harsh landscape. These plantings, also described in the plant list included in the permaculture report would consist of plants more familiar to European food gardens, such as apples, pears, and grapes, brought right to the front entry. In discussions with Grand County of the grey water garden, which would be located just downhill from the rest rooms (using just handwashing sinks) and cyclist showers, and just outside the glazed student commons, this feature could become a precedent for the larger community of Moab for how such a system could be installed and permitted safely to make a precious resource out of what is usually considered waste.

LAND TENURE & COMMUNITY GOVERNANCE

To meet the community goal of having a net-zero, or rainwater subsistent, landscape design the team assessed the storm water quantity of the first node of the campus development beyond the first building, shown in the plan below. A swale was designed down-slope of each building shown in the master plan to harvest the runoff from a 24 hour storm follow-

PUEBLOAN ACEQUIA. SANTA FE, NEW MEXICO

CAMPUS NODE STORM WATER ANALYSIS PLAN

ing a 48 hour period of no measurable precipitation, also accommodating geothermal well-fields for each. Estimates were then created to the amount of water harvester per month from each building roof and hardscape, to determine the quantity of mesic landscaping that could be accommodated with the rainwater budget. The plan also shows the green space or commons that becomes the nucleus of the academic village. Turf is the ideal material for this space as it needs to be able to accommodate an outdoor concert, or students throwing a frisbee. However the amount of turf that could be sustained by the rainwater collected from the roof of this first building, and stored in a 5.000 gallon cistern is just 1,200 square feet, and not enough to function as a commons. It was therefore decided that the rainwater from this first building would be initially focused on establishing the mesic plantings that help sustain and shade the building. The turf shown in the adjacent preliminary landscape plan was replaced by an acequia feeding shade trees to the Southwest of the academic wing.

Once these are established and the subsequent buildings start to follow the water would be diverted to sustaining a turf commons, assisted with the water

PRELIMINARY LANDSCAPE PLAN

PRELIMINARY PARKING PLAN

from the other roofs. Excess rainwater at that point could also be used to offset water used for flushing toilets as well.

Two options for parking were assessed: one to the Northeast and the other to the East of the road. Although the former allows a drop-off space and it could tie in to the future SITLA housing to the North, the parking on the East was chosen for its better drainage (feeding plantings in the medians) and because it more easily accommodates adequate parking while simultaneously moving it out of view of the building as it is approached from the road. The parking there provides space for 80 cars in the first two lots on the west side, and an additional 80 spaces in the gravel overflow on the east side. This provides one space for every two students at maximum capacity, which should be more than adequate for the building which will, at least initially, have a more spread out use with a mix of traditional and non-traditional (night class) student body.

FINANCE & ECONOMICS

Using Building Information Modeling (BIM) to model the budget along with the space planning, material use and material quantity, allowed the design team also to evaluate the cost impact of the building systems, and sought out ways of sizing, siting and shaping the building to utilize freely available natural services, rather than imported/purchased energy to sustain it.

DYNAMIC MODELING

To ascertain the impact of the building form on the energy use, with relevance to the on-site conditions, energy model simulations were used to take the geometry of the third design option - evaluating how well it would perform with regard to the specific spaces in it and how they interact with solar gain throughout the year, also assisting in the sizing of the mechanical systems. A simple geometrical model was developed to run the simulations, assessing energy use and daylighting, helping to inform the orientation of the building and the organization of its facade and glazing. Various configurations of windows and their locations were evaluated, to capture passive solar heating during the cold months and passive cooling in the hot, but the building's use and its organization, its dominant energy use was for cooling. It is evident from the graph to the right from the red (heating) and blue (cooling) lines that cooling will happen year round, but also that these loads for nearly half of the year (the heating season) are nearly balanced. This is encouraging for a radiant heating and cooling system (as in a geothermal system), because there would be a net zero energy load during much of that time - spaces which are too warm on a sunny winters day can send their excess heat to spaces on the north side of the building which are too cold. However, as a baseline, an alternate VAV system was outlined for consideration as well.

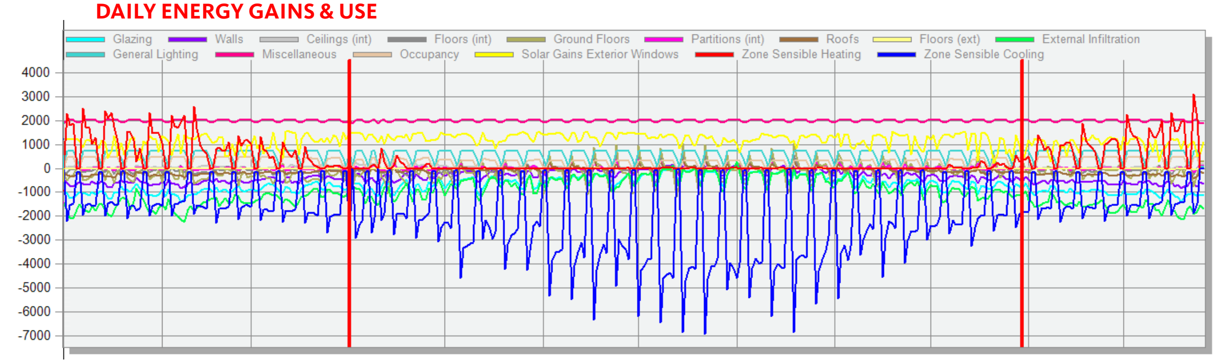
HVAC SYSTEM DESIGN GOAL

Efficient, maintainable means to provide HVAC to an expanding campus.

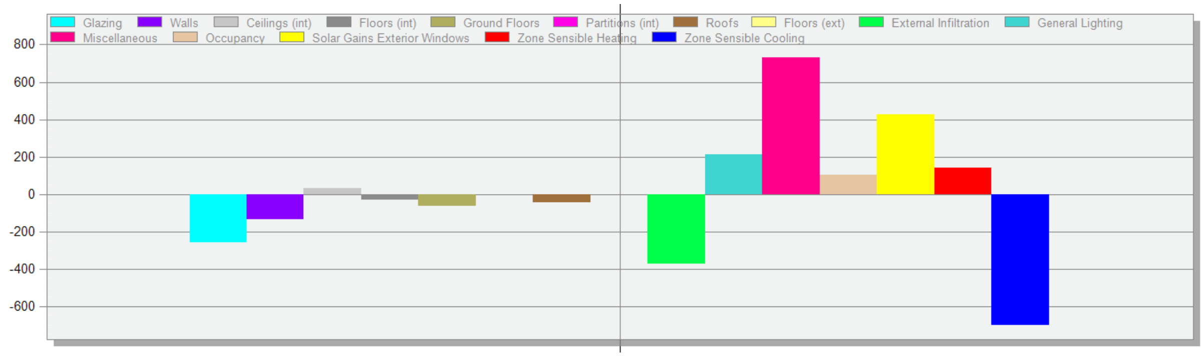
MECHANICAL AND PLUMBING DESIGN GOALS

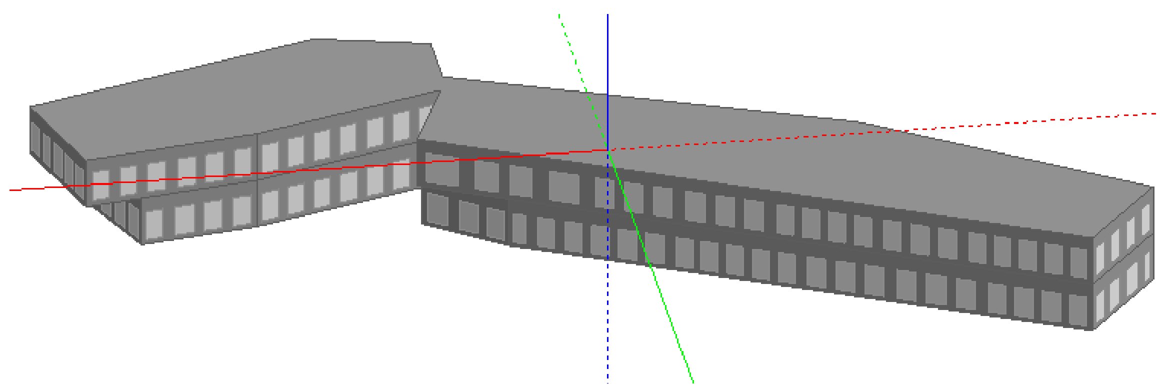
The design goal for the mechanical system to be used for the first building on the campus is that it be efficient and maintainable. Early in the process, a central plant was considered which would deliver chilled water and possibly steam in tunnels from the plant to each building on the campus. However, given the small size of the first building, it was determined that the project would be more economically served by a standalone system. Future projects and development of

DAILY ENERGY GAINS & USE



ANNUAL ENERGY GAINS & USE





25% GLAZING ENERGY MODEL

the campus should consider the addition of a central plant in the future in the planning process and the tunnel routes to connect the buildings on campus to the plant.

Based on a standalone system, the baseline system considered was a single VAV air handler, with chilled water cooling and hot water reheat. Air-cooled chillers and modular, non condensing water tube boilers could be utilized. The air handler coils would be sized for a large (20o) delta-T, to minimize future flow requirements. Mechanical rooms are to be located in the new buildings on the exterior side of the building, so that when the central plant tunnel is installed, connections to the tunnel will be straightforward. Also, the mechanical systems should be designed so that future central plant connections can be easily made. The mechanical design should also take into consideration a future connection to the central plant, which will include a cooling tower being added to the building, and the existing air handlers being converted to evaporative cooling. The cooling tower will likely be installed on the roof, so that plans to provide structural accommodation should be taken into account.

A second mechanical design approach considered was water sourced heat pumps. This design anticipates heat pumps being distributed throughout the building, and connected to each other with a common condenser water loop. The loop allows load within the building to be shared between individual heat pumps – zones that need heat extract heat from the condenser loop, and zones that need cooling reject heat to the loop. If the condenser loop gets too warm or too cold, it is diverted to boreholes in the ground, where it exchanges heat with the ground. Since the campus will be cooling dominated and will annually need to reject more heat to the ground than it needs to absorb, a hybrid system can be used to reduce initial cost. In this system, some of the heat rejection is accomplished with an evaporative cooling tower, which allows the ground loop to be smaller and less costly. As the campus grows, the buildings can be interconnected in order to share load between the buildings, and the ground loop expanded in order to accommodate the increased load. Ventilation air would be provided by a dedicated outside air system that provides the exact amount of outside air to each zone based on occupancy.

The water-source heat pump system was determined the most appropriate for the building and the costs for this system are included in the cost estimate. The plumbing design assumes 1.28 gallon per flush (gpf), manual flush valve wall hung water closets, 0.125 gpf, sensor flush valve urinals, and 0.5 gpm sensor faucets with individual tempering valves at each faucet. Classroom buildings will have 2” supply and 4” sewer. Buildings with food service will have a 2-1/2” supply and 4”sewer, with separate 4” grease waste that is routed through an exterior grease interceptor and combined into a 6” building sewer. Water heating will be with gas-fired, condensing water heater with storage.

COMMONS/ATRIUM PRECEDENT

HEALTH & WELLBEING

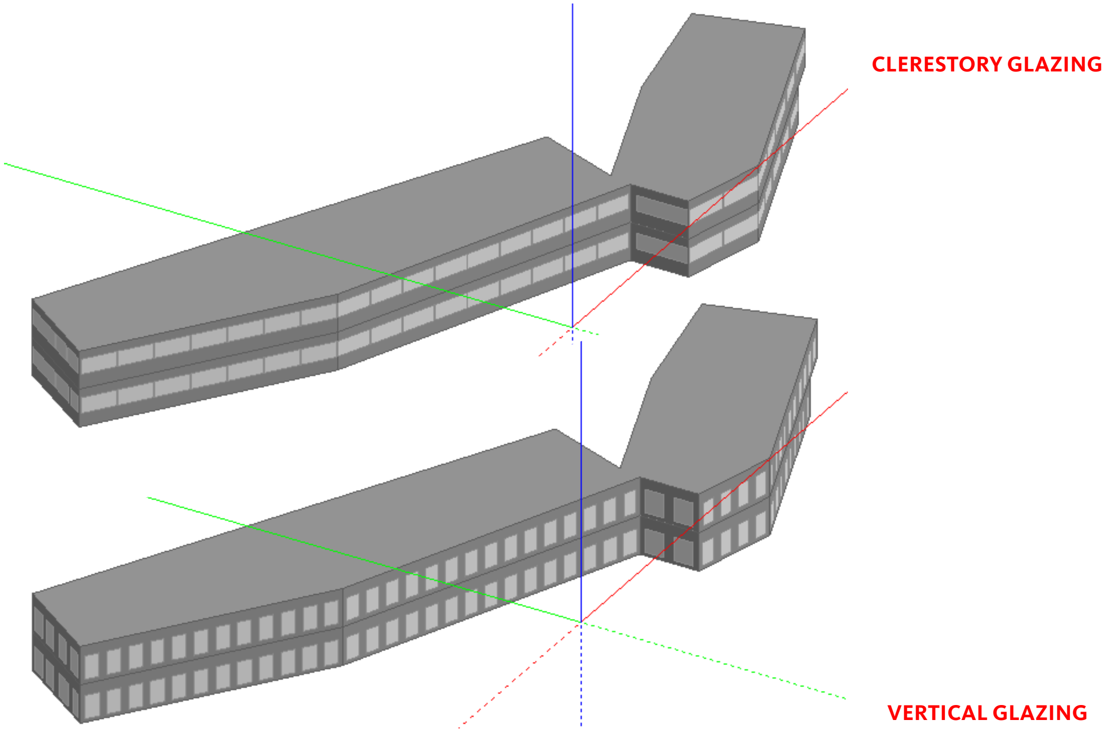
The strategies employed in designing the building and landscape systems aim to employ natural services (passive water harvesting, solar power, solar heating, geothermal cooling) to build natural capital in the landscape (thermal comfort, water storage, food producing crops, shade, biodiversity). All of these serve to show how a shift can be made from a model of active consumption to one of active production. This shift can create economic wellbeing in terms of return on investment but will also foster a healthy landscape and ecological community, in turn fostering health for the people inhabiting it.

VIEWS

One goal of place based education is providing students, faculty and staff with opportunities to 'get their hands dirty' (picking fruit from the gardens in the courtyards, participating in the planting or maintenance of food forests), and giving them close-up views, particularly in the 'garden level', to those plant systems. This allows for the development of a deeper connection to nature - the building becoming a teaching tool and interactive learning environment.

DAYLIGHTING

Building on this connectivity to the land and the State of Utah requirement for compliance with low-emitting paints, coatings, adhesives, sealants and flooring, the design aims to round out the indoor environmental quality with good daylighting and views, without compromising on energy efficiency - especially as pertaining to cooling excessive solar gain from windows. Using the energy model created for the building, various approached to daylighting were explored. The two configuration options shown here illustrate how horizontal clerestory windows compare with vertically oriented windows. With either option, meeting the LEED daylighting credit criteria is difficult with a 25% window to wall ratio (even more-so with LEED v4, which has not yet been adopted). The clerestory windows function better at getting light deeper into the space, but would not give the occupants the desired access to views of the horizon or immediate landscape. The horizontal windows are also harder to shade from hot afternoon sun than the vertical windows are. The vertical windows were therefore chosen for development for views, while sola-tube type daylighting fixtures can be used for improving daylighting in the classrooms. These can not yet be modeled for daylight effectiveness and would need to be verified by the alternative track for compliance with the LEED daylighting criteria of on-site measurement. This compliance path may also benefit the project as there is typically a high reflectance in the Moab landscape which will increase available daylight, but can not easily be simulated in a daylighting model.



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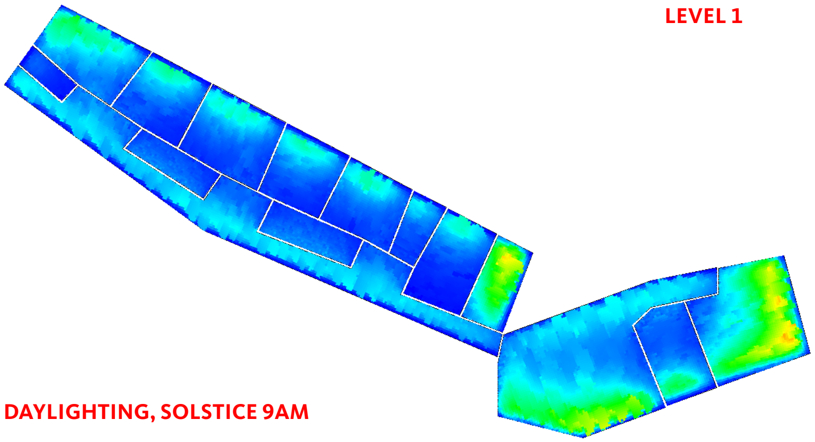

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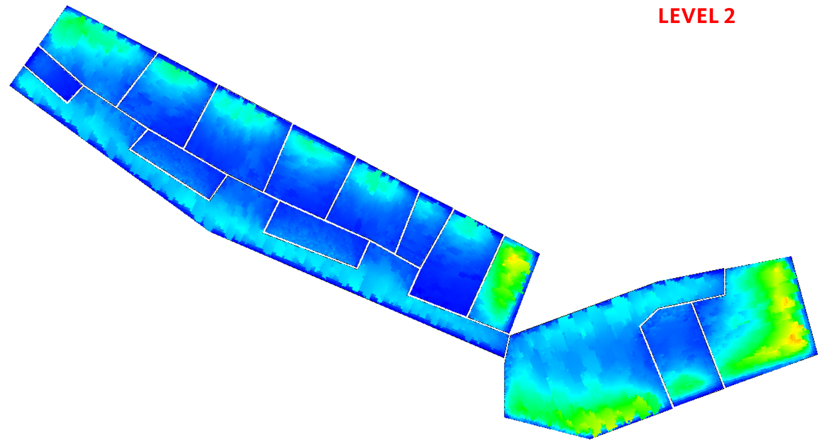
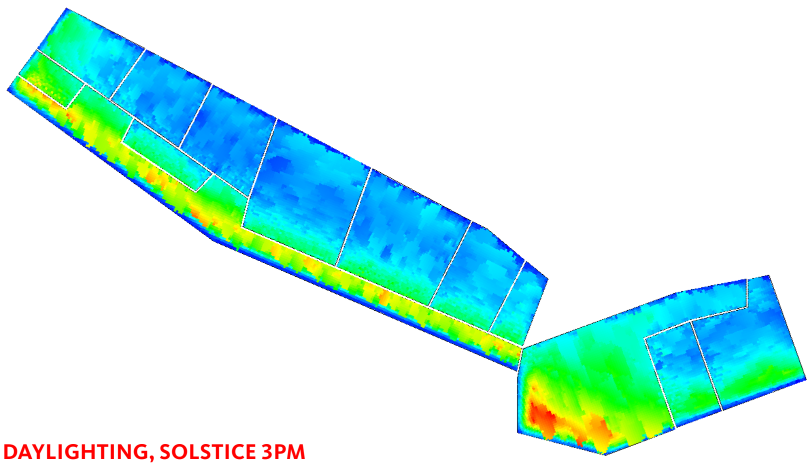
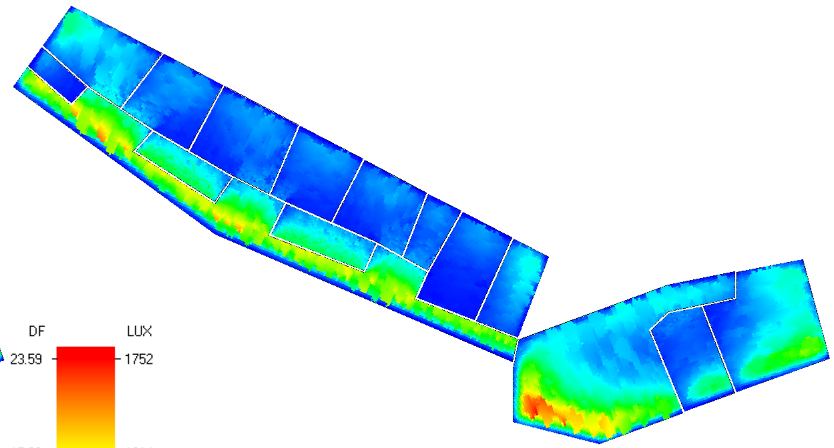
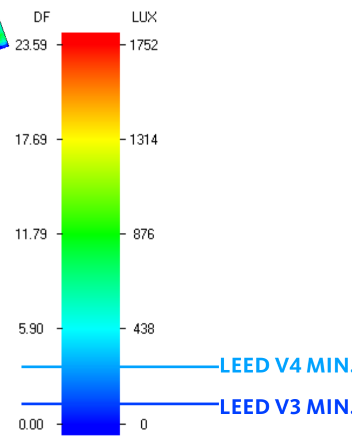


DAYLIGHTING, SOLSTICE 9AM

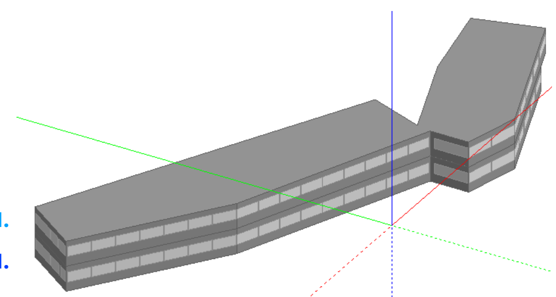




DAYLIGHTING, SOLSTICE 3PM

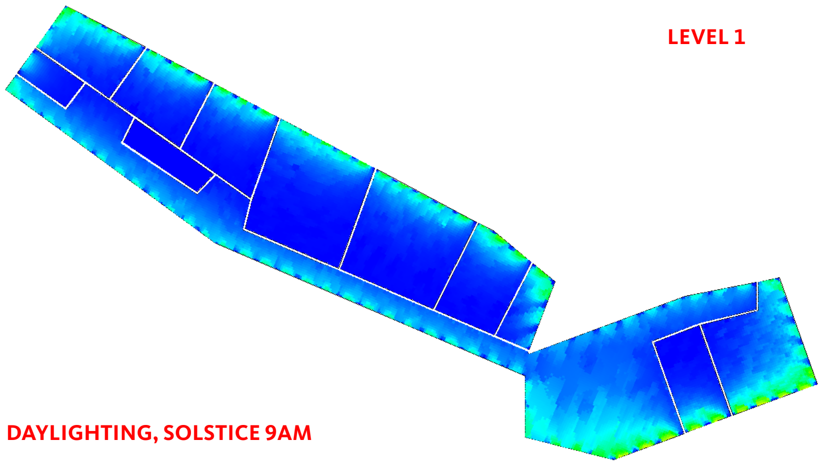


DAYLIGHTING KEY



CLERESTORY GLAZING

LEVEL 1



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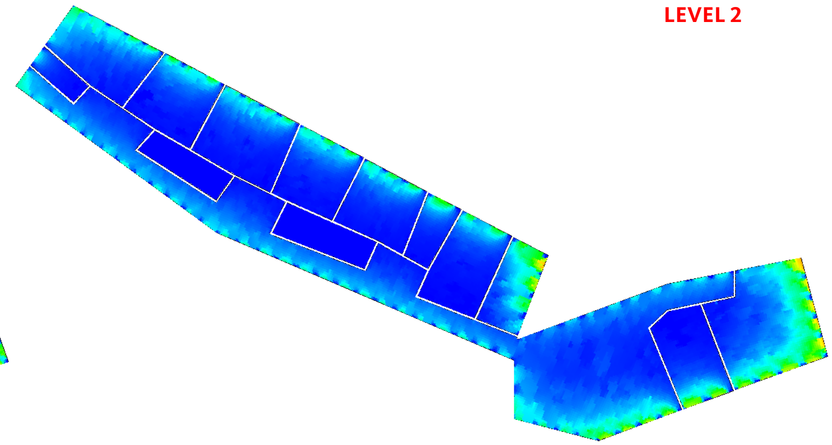

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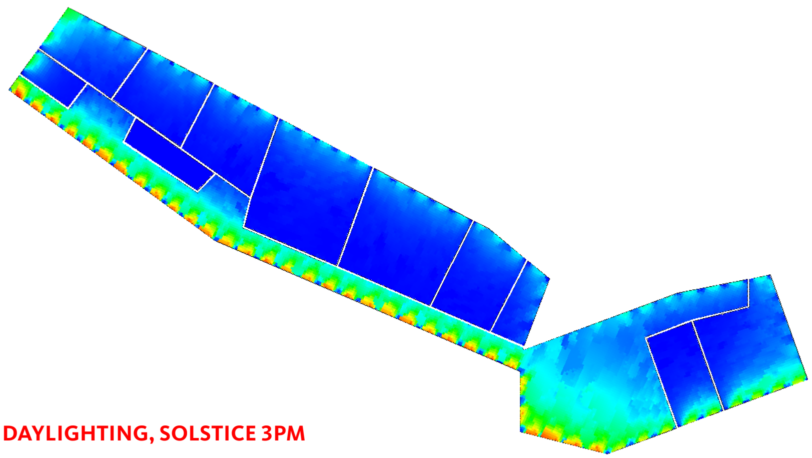

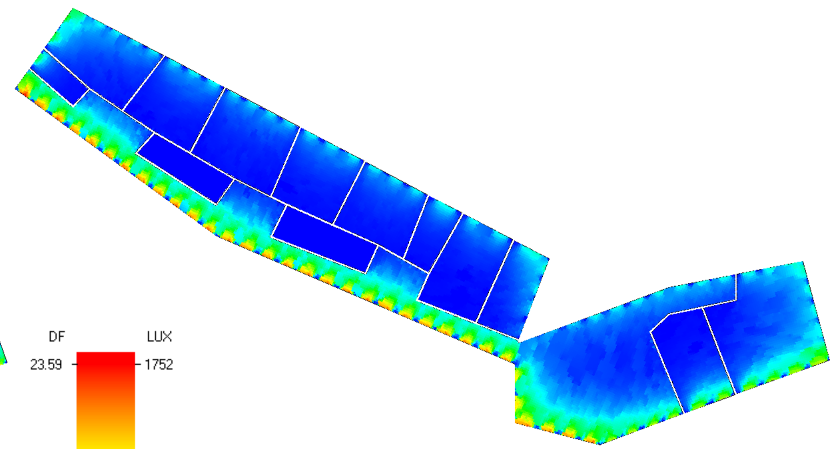

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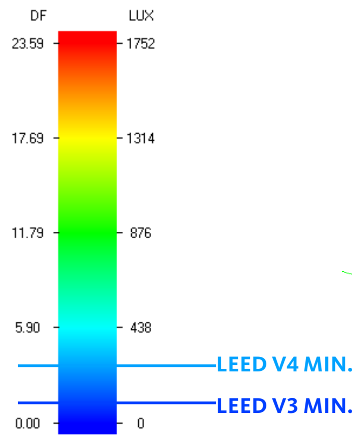

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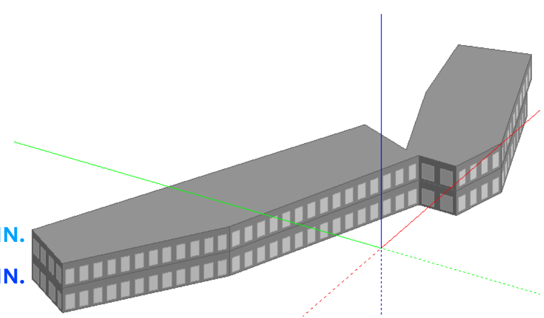
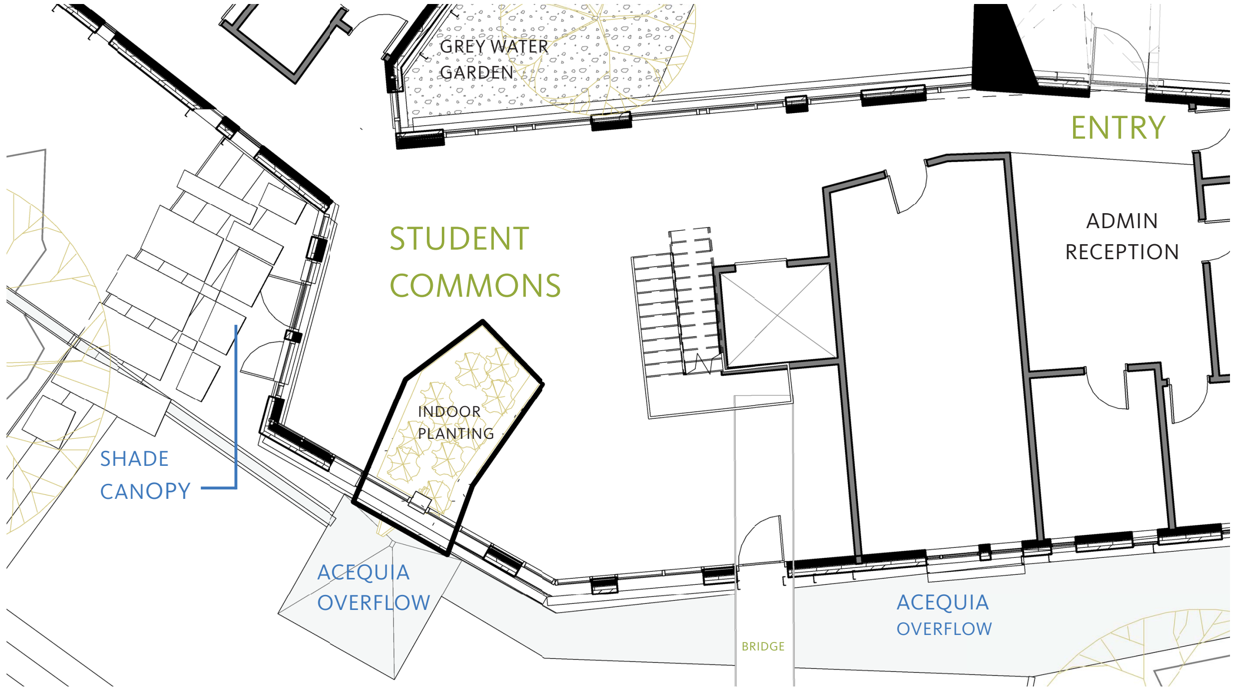


VERTICAL GLAZING

GROWING FRESH AIR

As a means of extending the connectivity between the indoor environment and the landscape, an indoor wetland feature is proposed in the student commons. This indoor planting would be tied into the roof rainwater harvesting system, visibly filling during a rain event, the water level falling during dry-spells. Stacked with plants from NASA's list of plants which have been proven to improve indoor air-quality, it would not only allow students to celebrate and engage with rain events, but would act as an additional biological and symbiotic air filter.

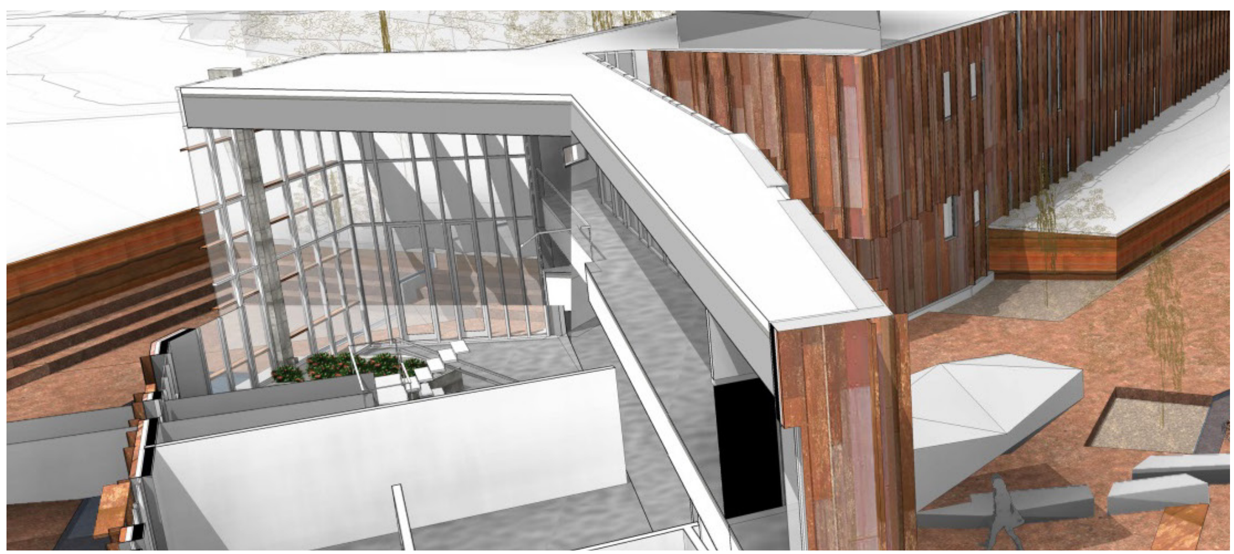
ENLARGED COMMONS PLAN



CULTURE & EDUCATION

The USU Moab Phase One Building will be a place that naturally instigates cross-disciplinary collaboration and innovation. This can be seen in the way that it combines old and new traditions of place, such as the puebloan water conveyance technologies and geothermal heating and cooling. In a similar way to how the interface between the built and wild environments becomes blurred by its adjacency and overlap, informal mixing spaces at the intersections of classrooms become areas where ideas are exchanged, sparked and inspired by spontaneous interaction between students, their peers, instructors and nature.

There are six mixing spaces, three on each



CUTAWAY RENDERING

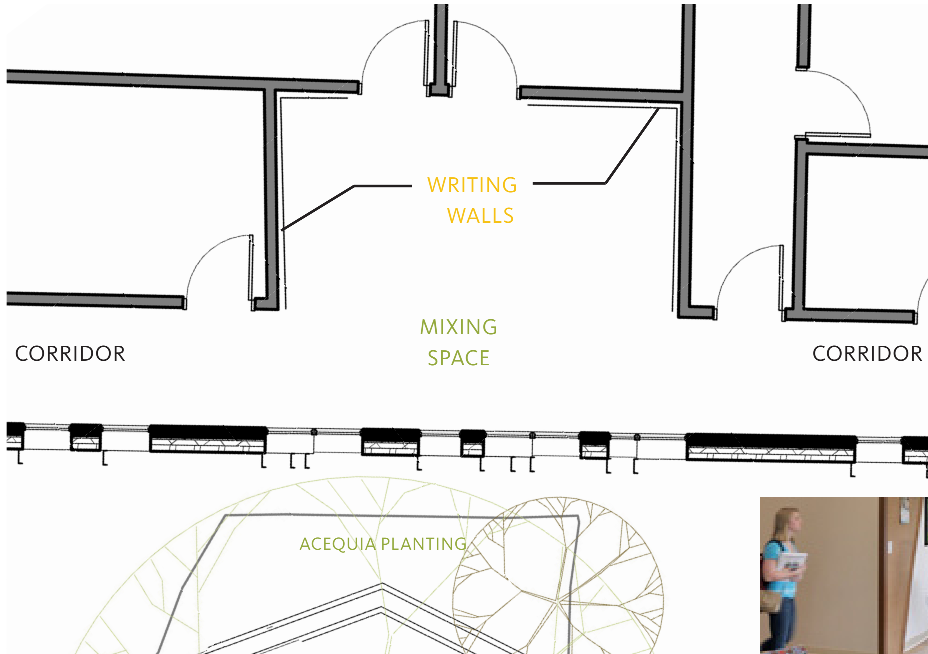
level, configured in two different ways. All are located at the entry between two classrooms, and are located next to fully glazed sections of wall situated in the shade of the larger shade trees and acequia sustained plantings on the southwest side of the academic wing. In the garden level the view of these would be at eye height - up close and personal, whereas on the second floor it would be more of an overview of the planting.

Half of these spaces consist of white-board covered walls which become spaces where students can draw and brainstorm ideas, where teachers can stop to diagram a concept and where general collaboration and discovery can take place.

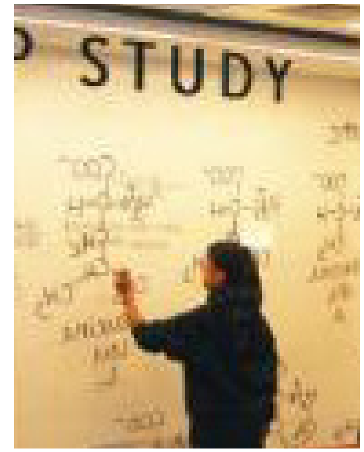
The other configuration consists of banquette and table seating where students can study, meet, or eat a snack. These can include screen and data connections to facilitate conference meetings and group distance learning.

Either of the two configurations can be combined with moveable soft seating and tables to accommodate impromptu group meetings or project tasks.

The corridor thus expands beyond just circulation space and becomes programmable, usable education space.

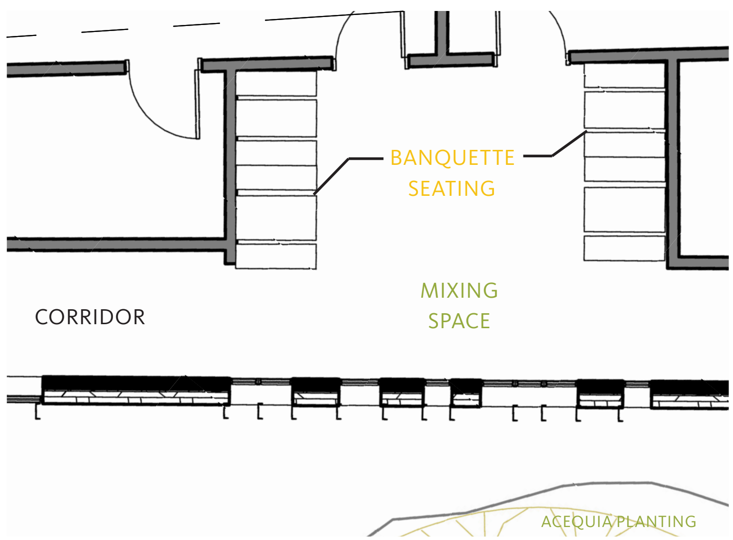


ENLARGED MIXING SPACE PLAN TYPE 1



INTERACTIVE WRITING WALLS

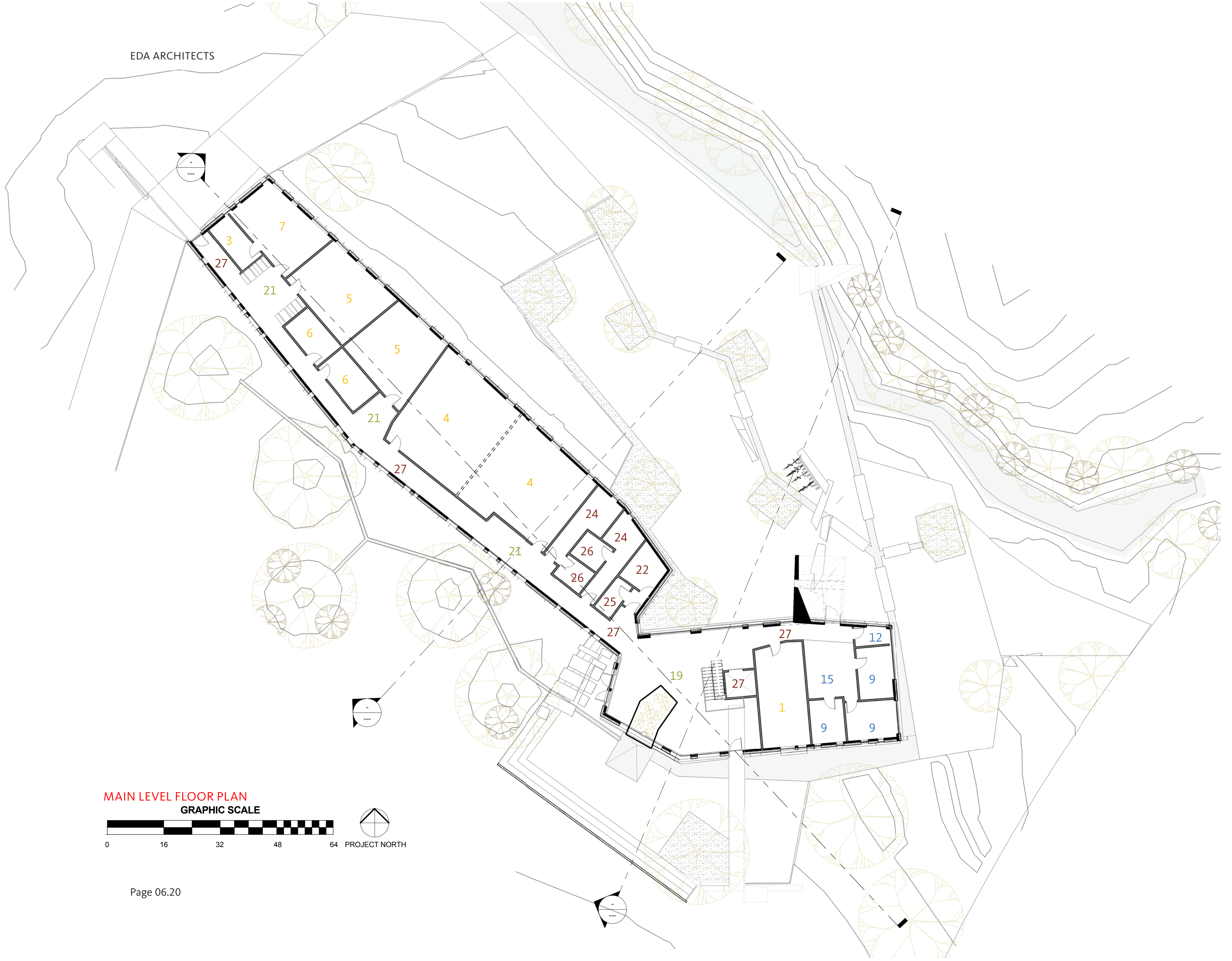
SOFT SEATING



ENLARGED MIXING SPACE PLAN TYPE 2

BANQUETTE SEATING

EDA ARCHITECTS



MAIN LEVEL FLOOR PLAN

GRAPHIC SCALE

0 16 32 48 64

PROJECT NORTH

1	COMPUTER LAB
2	GROUP ONLINE CLASSROOM
3	LAB STORAGE
4	LARGE CLASSROOM
5	MEDIUM CLASSROOM
6	SEMINAR
7	WET LAB
8	DRY LAB
9	ADMIN OFFICE
10	FACULTY BREAK ROOM
11	FACULTY OFFICE
12	MOTHERS ROOM
13	RECEPTION/WORK
15	STAFF OFFICE
16	ACADEMIC SUPPORT
17	COFFEE BAR
18	REGISTRAR COUNTER
19	STUDENT COMMONS
20	TESTING
21	MIXING SPACE
22	MECHANICAL
23	ELECTRICAL
24	REST ROOM
25	JANITORIAL
26	SHOWER
27	CIRCULATION
28	BRIDGE

UPPER LEVEL FLOOR PLAN

GRAPHIC SCALE

0 16 32 48 64

PROJECT NORTH

SOUTH MTN. COMMUNITY LIBRARY, RICHARD + BAUER

TOOLS & TECHNOLOGY

The USU Moab Phase One Building takes inspiration from tried and true traditional building practices in Moab and the surrounding region. Using materials, such as the rusting steel in the Moab Colorado River Bridge, which have a history of use unique to the area and excel by merit of their innate characteristics and performance in the arid climate, have the potential of reinforcing patterns of building and behavior that are appropriate and healthy for the bioregion. While not a renewable resource, steel contains recycled material, has low-waste (due to recycle-ability), has a high durability, very low maintenance, and shows a naturally developing patina as it engages the elements. The library building above was a precedent looked at for the use of steel siding which would be emulated in rusting, or CORTEN steel, for USU Moab.

The images on the right additionally show how vertical steel channels affixed to the outside of the glazed portions of the building functions to cut out the hot afternoon summer sun, taking advantage of the fact that the windows are angled away from the noon-time sun, and as the sun works it way towards them (becoming lower in the sky) the shading devices work to cut the glancing rays out of the building. Continuous insulation behind the steel panels, and an air-tight building envelope will help to reinforce the cutting excess heat in summer (as well as keeping it in during winter months.

The flat roofs of the building are ideal for both solar photovoltaic panels to offset the electricity required to run the pumps for the radiant heating and cooling system, and for collecting clean rainwater to be stored in a cistern and used for landscaping.

The other materials on the site consist of rough concrete courtyard paving which slopes to divert storm water into the concrete formed acequias. The acequias carry the water in shallow channels - evocative both of the court of oranges in Seville and a wash in a slot canyon - into recessed basins planted with food forest groupings.

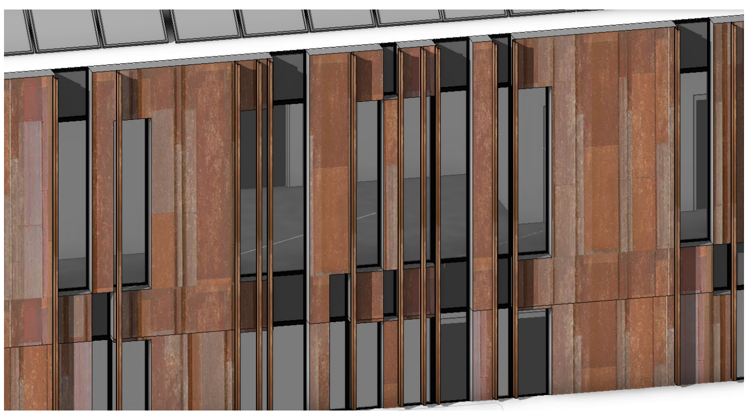
The acequias overflow on the downhill side of the site through the monumental sculpture - engaging it during a rain event - and are deposited into the downslope swale, feeding the dryland food forest. Board-formed concrete is used to create the monument, as well as the sculptural benches and entry, giving them a stratified appearance to echo the sandstone formations that they reference in Moab's landscape.

COLORADO RIVERWAY BRIDGE

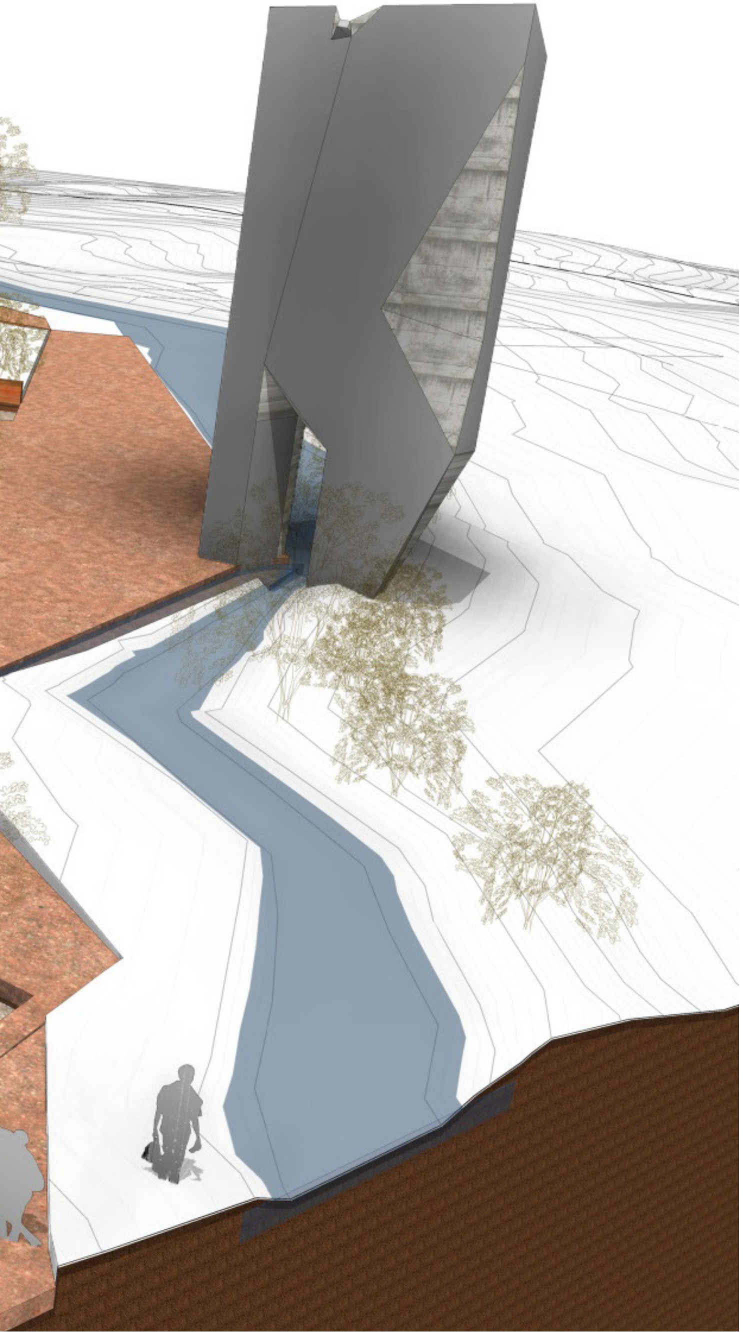
ACEQUIA & IRRIGATED GARDEN BASIN, SANTA FE

SOLAR SHADING 2PM, SUMMER SOLSTICE

SOLAR SHADING 3PM, SUMMER SOLSTICE



SOLAR SHADING 4PM, SUMMER SOLSTICE



SECTIONAL RENDERING

BUILDING SECTION, ACADEMIC WING

THE BUILT ENVIRONMENT

A series of retractable canvas awnings provide shade in the south facing courtyard to provide a pleasant and habitable space there in the years before the shade trees establish themselves. Over time what grows on the site is a place of increasing habitability, of shade, of temperate spaces, edible gardens, and spaces for recreation. A jumping-off point for excursions into wilder parts of the site and surrounding landscape, and a welcoming place to come to learn in and from the building and landscape.

By integrating the rainwater harvesting mechanisms into the building and surrounding landscapes, and by sizing the plantings based on the available precipitation, the USU Moab Phase One Building is a step in the direction of sizing the built environment on the available natural resources and services. By recessing the building into the grade, taking advantage of the cooler earth temperatures in the summer, and orienting the windows to allow them to be easily shaded from the hot summer afternoon sun, the building

BUILDING SECTION, STUDENT COMMONS

keeps the cooling loads low by drawing as much as possible from the resources and opportunities of the site.

In addition to this, the building celebrates the natural process that it relies on so that they can be perceived, understood, and valued. Rain chains connect roof scupper drains to the acequias, which in turn fill, and overflow - nourishing plantings, crossing walkways, and engaging sculptures. Rain events become exciting times to inhabit the building and its environs.

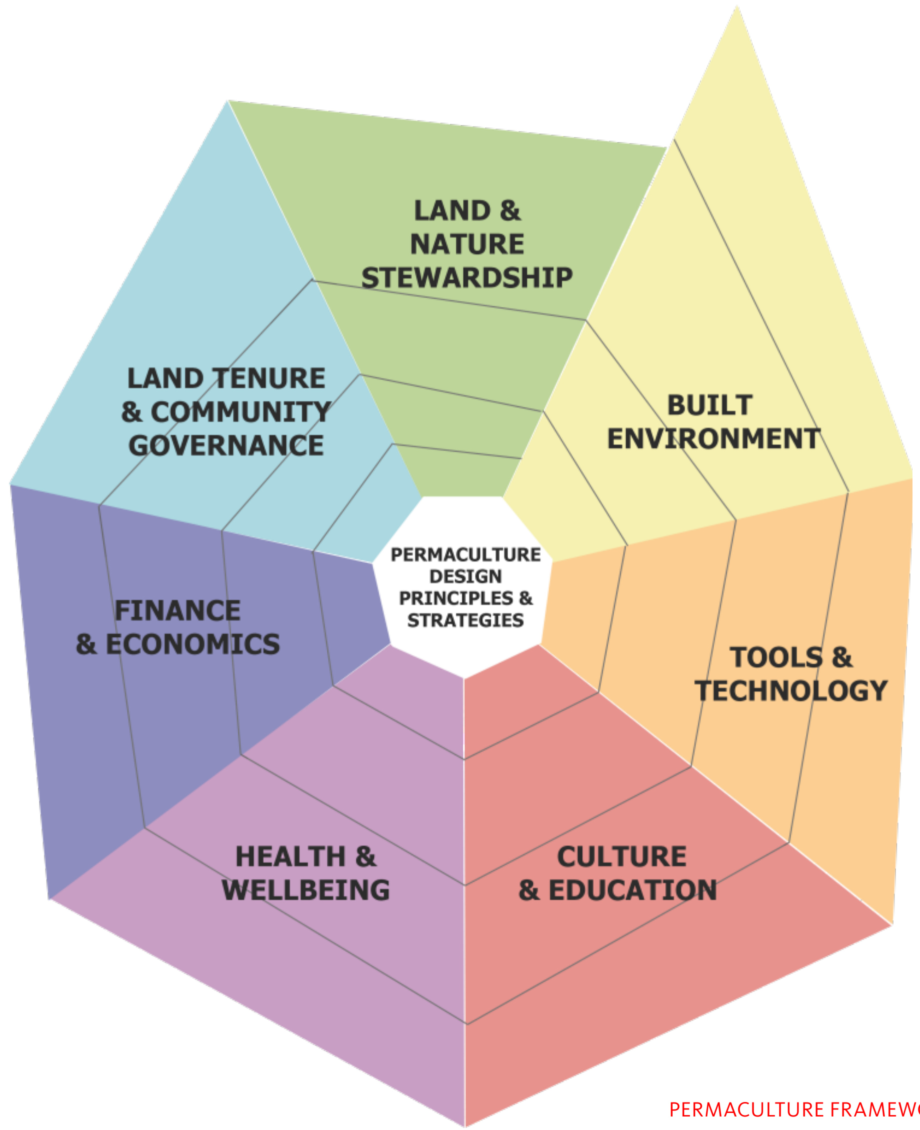
07.

PERMACULTURE ANALYSIS

PERMACULTURE ANALYSIS

During the community workshop, in addition to Utah State's High Performance Building Standard, USU's Climate Action Plan, and the LEED certification program, other frameworks were considered for evaluating a comprehensive and innovative approach to what is possible to achieve with building performance. One of these programs was the Living Building Challenge and the other was Permaculture Design. Both are similar in that they push the envelope of what is considered standard practice for construction industry, encouraging a rethinking of how things might be done to bring a building into balance with its immediate and global environs. After reviewing the Living Building Challenge, it was recognized that some of the imperatives would not be achievable in Moab's climate, namely the net-zero water imperative that stipulates for all water to be used in the building from faucets to irrigation to be captured from its roof. With but 9 inches of rain captured per year on its roof, this would be an impossible task for any building in Moab. The discussion did however inspire a goal, to achieve net-zero water for the irrigation of the landscape - that all water used for plantings surrounding the building be harvested, and captured from the site itself. Because USU had embarked on a similar project with its 'Bee-Inspired' gardens and with its new rainwater harvesting garden at its downtown Moab campus, using Permaculture Design to set up the necessary systems, it was determined to use a similar approach for the USU Moab Phase One Building.

One framework used in Permaculture Design to assess a projects performance with regard to its resources, community and environment is summarized above. This framework looks at seven sectors or domains of impact of a project, and how the principles and ethics of permaculture can be applied to re-think typical approaches to the building prospect, and discover new ways of solving the same problems that reinforce positive, rather than detrimental, relationships between the building and the communities of the different domains (including ecological as well as human constituents). With each wave of re-thinking the domains, the whole system becomes successively more resilient.



PERMACULTURE FRAMEWORK

OBJECTIVE

The objective is thus to introduce innovative solutions to economic or environmental problems which are mutually beneficial, particularly with an eye to how each part effects the whole.

The ethics of Permaculture Design uses to evaluate any given strategy are:
1. Care of Earth,
2. Care of People,
3. Reinvesting surplus to care for Earth and People.

The body of design principles that have evolved since the inception of the Permaculture Design Science in the 1970's were recently summarized by one of its cofounders, David Holmgren, into the following 12 principles, (which are followed by observations of how they are applicable to USU Moab):

1. OBSERVE & INTERACT

The design needs to draw from first hand observation and hands-on experience, but also recognize that many of the problems that we are setting out to solve are problems of thinking and design, which would be well served to use biomimicry, or observation and imitation of nature's wealth of solutions. Often times, the problems we undertake can be reformulated as solutions if we turn the tables of our thinking.

2. CATCH & STORE ENERGY

The proverb 'Make hay while the sun shines' captures the intent of this principle, advocating for the building of natural capitol in the landscape, and balancing idealism with pragmatism, short-term thinking with long-term.

3. OBTAIN A YIELD

Often times net-zero approaches to building are held up as the most cutting edge approach to reducing pollution. However, this strategy really only gets at half of the problem, which is the importance of encouraging awareness and numeracy in the consumption of energy. The other half is recognizing the importance of shifting our values from those of consumers to those of producers, and finding ways for our buildings to produce more resources than they consume.

4. APPLY SELF REGULATION & ACCEPT FEEDBACK

The design needs to respond iteratively to feedback, whether that comes from the community, from an energy model, or the budget; balancing the thinking from the top-down, with the action from the bottom-up.

5. USE & VALUE RENEWABLE RESOURCES

One goal to keep in mind, particularly with USU's goal of climate neutrality by 2050, is to develop infrastructure that is maintainable by natural services freely available on-site, rather than by energy imported to it. How can the soil, sun, rain, and wind available to the building be valued and inventively be put to use?

6. PRODUCE NO WASTE

How can the project refuse, reduce, reuse, repair, and recycle, in that order of importance? Finding ways to reduce or eliminate the work of maintenance is also essential, however this needs to be balanced with an understanding of the *durability* of maintenance and of a building considered beautiful and valuable enough to be well-maintained.

7. DESIGN FROM PATTERNS TO DETAILS

Just as in nature, where patterns have a degree of similarity and recognizability at different scales from global to local, these patterns can be used to inspire strategies at the landscaping, building, and room scale.

8. INTEGRATE RATHER THAN SEGREGATE

The strategy of feeding two birds with one crumb gets at the heart of this principle, recognizing that we need to use our innovation to reinforce positive relationship between the built environment and its ecological community. Often times, cross-disciplinary thinking and dialogue is essential to accomplishing this.

9. USE SMALL AND SLOW SOLUTIONS

As the saying goes, 'Slow and steady wins the race'. Incremental change combined with true innovation can have far-reaching effects.

10. USE & VALUE DIVERSITY

Functional diversity can be measured by the number of distinct positive, and self-sustaining, relationships between elements in a system. Increasing the number of these improves the resilience and sustainability of a system.

11. USE EDGES AND VALUE THE MARGINAL

Often times the most productive part of a natural system is at its boundary with another one, where the two overlap. Encouraging and maximizing such overlap can facilitate a more dynamic and productive environment.

12. CREATIVELY USE & RESPOND TO CHANGE

Looking to natural systems for examples of how ecological communities respond to environmental changes - how they move from conditions of scarcity to abundance - we can start to model our designs and maintenance strategies after nature to foster systems which create abundance for both people and ecology.

AIMING FOR ECOSYSTEM HEALTH

CONTEXT FOR THE NEW CAMPUS

ECOLOGY:

Ecologically speaking, the land for the new campus of Utah State University-Moab is an upland desert of the Colorado Plateau. This ecosystem is relatively barren except for a few high UV and extreme-dry tolerant shrubs, grasses, and forbs. It is a very degraded ecosystem from its original state of health. Due to extreme over-grazing of the Colorado Plateau significant grasslands have been removed, biological soil crusts have been destroyed, and the climax ecosystem altered. The Colorado Plateau ecosystems developed with low concentrations of grazing animals, and consisted of significant areas of shrubby grasslands. Many of these grasses are grazing intolerant and easily destroyed with the presence of grazing animals.

During the open range policy of the 1800's and early 1900's sheep and cattle were introduced to the Colorado Plateau and have left their mark on the ecology as the present ecosystem we see in the area. Moab in particular is a transition ecosystem in many respects due to the close proximity to high mountains and major riparian corridors. The new campus site however, is fully representative of non-riparian, non-mountainous over-grazed Colorado Plateau, which originally consisted of shrubby grasslands with Pinyon-Juniper woodlands scattered throughout.

RESTORATION AND DESIGN:

Using a permaculture design lens to view the current state of ecosystem health on the new campus site it would be imperative to aim toward restoring the ecosystem that was, rather than mimicking the ecosystem that is. There is one caveat to this however.

A significant altering of the ecosystem will occur when buildings and hardscape infrastructure are added. Impervious surface will be the main characteristic of these additions leading to copious amounts of rainwater runoff. If unplanned for, this runoff can cause massive erosion. If planned for, this runoff can be a resource as irrigation to grow shade trees and other vegetation to reduce the other potentially negative impact of adding buildings and infrastructure to this landscape, which is heat island creation. Another effect of adding buildings in particular will be the creation of varied microclimates, which allows for greater species diversity in plantings. What the large quantity of runoff will do is change the precipitation climate around the buildings and hardscape. It's important to understand this so that the right ecosystems are being aimed for in the right places.

Pattern Recommendation:

With all of the above in mind, we would recommend aiming for a riparian landscaped ecosystem around the buildings and in the courtyards, gradually transitioning to restored native ecosystem on the margins. The pattern this will set up is one of lush vegetation around the buildings and people, creating a much more inhabitable feel and function to the campus than the restored native ecosystem could provide.

RESOURCES:

-Sherow, James. 2007. The Grasslands of the United States: An Environmental History. ABC-CLIO inc. Santa Barbara, CA.

-Schwinning, S., J. Belnap, D. R. Bowling, and J. R. Ehleringer. 2008. Sensitivity of the Colorado Plateau to change: climate, ecosystems, and society. Ecology and Society 13(2): 28. [Online] URL: http://www.ecologyandsociety.org/vol13/iss2/art28/

PERMACULTURE DESIGN RECOMMENDATIONS

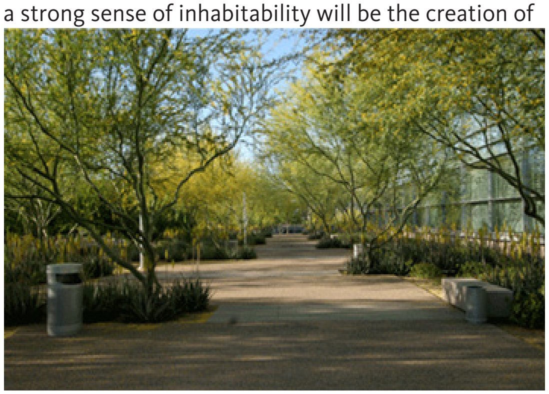
OVERVIEW: LANDSCAPE/HARDSCAPE INTERFACE

A permaculture design lens was used to look comprehensively at the new campus plans and develop strategies and design recommendations for the development as a whole. There is a tendency to demonstrate permaculture in specific areas as landscape features, but its strength is in whole system planning and site element integration, which has been applied to this project.

Normally buildings and landscape are treated as separate entities, but with a permaculture approach we can see the two as inseparable. Rooftop runoff can be used to grow the landscape that will provide shade for the buildings and courtyards, grey water from the buildings can be used for the same purpose, and potentially there is enough combined harvestable water that a project could achieve net-zero water. Additional hardscape such as parking areas and courtyards have rainwater runoff that can be utilized as well.

SHADE:

An important goal that was featured in the master plan for the new campus site was to create a place people want to be. On such an exposed site with intense solar radiation, a main component of achieving a strong sense of inhabitability will be the creation of



RAINWATER IRRIGATED PARKING PLANTINGS

shade. Using rooftop and other hardscape runoff to grow this shade should be of primary concern, from the parking areas through the courtyards, right up to the buildings. A gradient of shade can be developed from the more exposed parking areas to the courtyards choosing different species that cast varying degrees of shade. In developing that sense of inhabitability, it's important to avoid creating a dense water-intensive shade oasis in the middle of the desert, but instead to develop a shade gradient that keeps the campus community in touch with the desert ecosystem and magnificent vistas while buffering from the extremes of the climate simultaneously. Deciduous shade trees can also be used to passively cool the buildings and pavement, thereby reducing heat island effect and energy consumption.

WATER MANAGEMENT:

It would be excellent to demonstrate a fully runoff-irrigated landscape/hardscape interface for Moab with USU as the pioneering entity. Net zero water might even be approachable as other building phases are completed, but starting with full landscape irrigation is a logical first step. This is achievable with the ecological structures being proposed in the design. Here's how...

ACEQUIA

An 'acequia' or traditional dryland water conveyance system, can serve as a means to distribute water from downspouts to landscape. This concreted channel can collect rooftop runoff and passively distribute that water using gravity. The acequias flow would lead to tree basins that contain and infiltrate the runoff. Each tree basin can act as a shaded moist nucleus from which landscaping would emanate, getting more and more drought hardy in plant selection further out from each basin. The acequia concept would make the water element of campus sustainability a highly visible and interactive demonstration.

COURTYARD BASINS

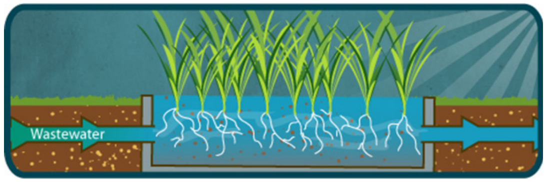
SHADED COURTYARD & WATER CHANNEL

The acequia can also run through the North courtyard with stone bridges across, and structural basins that double as seating and gathering spaces. Fruiting trees and other edibles can be planted in these basins, providing yet another layer of interactivity and sustainability concept demonstration. Broad canopied fruit trees should be selected for this courtyard area so as to maximize shade creation. An additional benefit to fruiting tree species in this area is the cooler microclimate provided by the North/Northeast aspect of the buildings which can delay flowering of the trees to a more appropriate time in spring so as to avoid late frosts.

GREY WATER

CURB CUT FOR LANDSCAPE STORM WATER INFILTRATION

GREY WATER IRRIGATION SYSTEM



Wastewater from bathroom sinks and ped-commuter showers can be used to irrigate trees and shrubs in the courtyards. This provides an ideal demonstration of water conservation as people directly interact with the flow. Special attention should be given to soaps and other products so as not to pollute the soil and landscaping. In general, in the arid west it's a good idea to avoid soaps with salts, and the same would apply to cleaning products. As long as the regularly used products are salt free and biodegradable, a few other products getting used occasionally won't be of concern. The grey water can flow through an artificial wetland, or reed bed, to passively and biologically filter contaminants before application to the soil. Such a reed bed is easily integrated into a courtyard for educational and aesthetic benefit.

SWALES

Swales, or elongated berms and basins, can be used to capture excess water flow from the acequia and overland flow during heavy rain events. A tenant of rainwater harvesting is to always have a structure that can capture overflow water, and to use that water as a resource. A large swale has been designed into the plan to serve that very function. Swales, if heavily planted with lush vegetation, can also act as wet lines for wildfire. When fire encounters large swales with moist landscaping it slows to a crawl and can even self-extinguish. A dryland food forest has been planned for the swale north of the courtyard, which will provide educational benefits along with ecological water management.

PARKING CURB CUTS

Parking lots are one of the most opportune places to develop ecological water management systems. If carefully designed, most parking lots can be self-irrigating simply by planning finished grades and hardscape to drain runoff into landscaping. Most parking lots are far too barren as well, and by developing a plan to ecologically manage the parking lot runoff, more vegetation needs to be incorporated, which in turn shades cars and people from the hot sun contributing to the overall sense of inhabitability on campus. The parking lot planned for the new campus site can capture all runoff through curb cuts in the vegetation islands, as has been demonstrated on the downtown Moab campus.

CISTERNS - ESTABLISHMENT, SUPPLEMENTAL, TURF

Cisterns are an effective strategy to capture rain in the wet months to have it for use as irrigation in the dry months. A cistern should be incorporated into the final design to serve the function of having supplemental water to use during establishment of the landscaping and during extended dry periods. It is recommended to have a cistern of significant enough size that it is meaningful for this purpose. 5,000 gallons or more would be meaningful for the phase 1 build out. Each future building should be considered for cistern catchment if there is ever a strong desire for large areas of turf on campus. Consider that the total runoff of one building centrally located could be dedicated to cistern catchment and turf irrigation. It would make a proud statement to be able to irrigate a central area of turf solely from roof runoff. In a climate like Moab, ideally cisterns would be buried to prevent UV degradation as well freezing in the winter.

CURB CUT FOR RAINWATER IRRIGATED PARKING PLANTINGS

FOREST GARDEN PLANT SPECIES CANDIDATES – USU MOAB

Function- Ecological and/or human uses
Site- Relation to buildings, slope, and/or water

CANOPY LAYER	FUNCTION	SITE
Prunus domestica - European Plum	Edible	North/East/West-Mesic
Malus domestica - Apple	Edible	“
Prunus persica - Peach	Edible	“
Prunus cerasus - Sour Cherry	Edible	“
Pyrus pyrifolia - Asian Pear	Edible	“
Zizyphus jujuba - Jujube	Edible	South/West-Mesic-Dry
Ficus carica - Fig	Edible	“
Prunus armeniaca - Apricot	Edible	“
Alibizia julibrissan - Mimosa	N-Fixer	“
Prunus amygdalus - Almond	Edible	“
Pistacia vera - Pistachio	Edible	“
Robinia pseudoacacia - Black Locust	N-Fixer	“
Pinus edulis - Two-needle Pine	Edible/Ethnobotanical	Dry
Juniperus scopulorum - Rocky Mtn. Juniper	Ethnobotanical	“
Juniperus osteosperma - Utah Juniper	Ethnobotanical	“
Crataegus douglasii - Black Hawthorn	Edible	North-Mesic
Celtis reticulata - Netleaf Hackberry	Edible	Mesic

SHRUB LAYER	FUNCTION	SITE
Prunus tomentosa - Nanking Cherry	Edible	South/West-Mesic-Dry
Prunus besseyi - Regular Sand Cherry	Edible/Ethnobotanical	“
Lycium pallidum - Wolfberry	Edible/Ethnobotanical	“
Spartium junceum - Spanish Broom	N-Fixer	“
Amorpha fruiticosa - False Indigo	N-Fixer	“
Amorpha canescens - Dwarf False Indigo	N-Fixer	“
Fallugia paradoxa - Apache Plume	N-Fixer	“
Amelanchier utahensis - Utah Serviceberry	Edible/Ethnobotanical	“
Eleagnus comuntata - Silverberry	N-Fixer/Edible	“
Sheperdia argentea - Buffaloberry	N-fixer/Edible	“
Cercocarpus ledifolius - Curl-leaf Mtn. Mahogany	N-Fixer	“
Caragana aborescens - Siberian Pea Shrub	N-Fixer	“
Rhus aromatic - Skunkbush Sumac	Edible	“
Ribes aureum - Golden Currant	Edible	“
Atriplex canescens - Fourwing Saltbush	Edible	“
Sambucus caerulea - Blue Elderberry	Edible/Ethnobotanical	North-Mesic

LOW SHRUB LAYER	FUNCTION	SITE
Yucca bacatta - Banana Yucca	Edible/Ethnobotanical	Dry
Opuntia engelmanni - Prickly Pear	Edible/Ethnobotanical	“
Hyssopus officianalis - European Hyssop	Pollinator Attractor	Mesic-Dry
Salvia officianlis - Culinary Sage	Edible	“
Perovskia atriplicifolia - Russian Sage	Pollinator Attractor	“
Lavendula sp. - Lavender	Pollinator Attractor	“

HERBACEOUS LAYER	FUNCTION	SITE
Echinacea purpurea - Purple Coneflower	Med/Pollinator Attractor	Mesic-Dry
Hemerocallis sp. - Daylily	Edible/Pollinator	“
Agastache sp. - Anise Hyssop	Pollinator Attractor	“
Gallardia sp. - Native Blanket Flower	Pollinator Attractor	“
Eriogonum sp. - Sulphur and Rim Rock Buckwheat	Pollinator Attractor	Dry
Oryzopsis hymenoides - Indian Rice Grass	Edible/Ethnobotanical	“
Penstemon sp. - Native Penstemon	Pollinator Attractor	“
Thelesperma megapotamicum - Hopi Tea	Tea/Pollinator Attractor	“
Sporobolus sp. - Dropseedgrass	Ethnobotanical	“
Cleome lutea - Yellow Beeplant	Ethnobotanical/Pollinator	“

GROUND COVER LAYER	FUNCTION	SITE
Dalea pupurea - Purple Prairie Clover	N-Fixer/Pollinator Attractor	Dry
Ipomea leptophylla - Bush Morning Glory	Edible/Ethnobotanical	“
Physalis sp. - Groundcherry	Edible/Ethnobotanical	“
Lupinus sparsiflorus - Desert Lupine	N-Fixer	“
Onobrychis vicifolia - Sainfoin	N-Fixer/Pollinator	Mesic/Dry

VINE LAYER	FUNCTION	SITE
Vitis arizonica - Canyon Grape	Edible/Ethnobotanical	Mesic
Vitis vinifera - Table Grape	Edible	“

SHADE SPECIFIC TREES	FUNCTION	SITE
Gleditsia triacanthos - Shademaster Honey Locust	Shade	Mesic
Morus nigra - Fruitless Mulberry	Shade	“
Plantanus acerifolia - London Planetree	Shade	“
Plantanus occidentalis - American Sycamore	Shade	“
Fraxinus velutina - Modesto Ash	Shade	“
Fraxinus arizonica - Arizona Ash	Shade	“
Chilopsis linearis - Desert Willow	Shade	“

FOOD FOREST MANAGEMENT

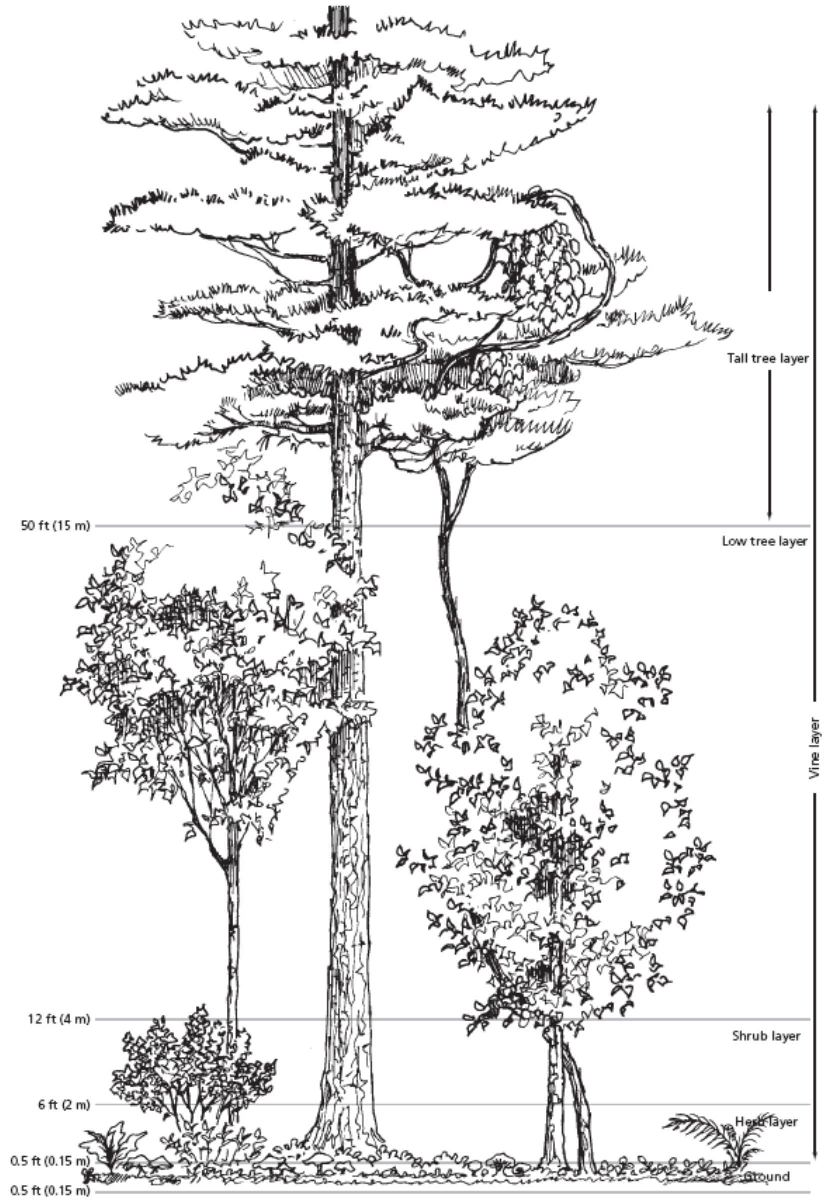
For the dryland food forest plantings in the swales, the following planting and maintenance plan could be adopted for a net-zero/rainwater subsistent edible landscape.

Immediately after earth-working, the water harvesting contour-ditches need to be seeded for erosion control. This can be accomplished with clover, lupine or sainfoin (annual nitrogen fixing plants). Within the first few years, hardy nitrogen fixing pioneer trees and shrubs should be planted out as seeds or seedlings en masse into the ground cover on the uphill and downhill sides of the ditch/path. Although these plants have no or low food use potential they comprise the foundation of the system whose primary objective is to compete with and replace the less human food use friendly weed communities that would typically move into freshly disturbed soil. They will lay the groundwork, soil stability and fertilizer for the edible plants to come. These plants which comprise 100% of the plant community initially will comprise of merely 10% of the biomass at the system maturity in 30 years time.

Year after year, nitrogen fixing trees and shrubs will be coppiced, or pollarded, stimulating a release of nitrogen from the die-off of the plant roots resulting from this pruning. In the place of the coppiced plants, edible species from the plant list are planted, always as seedlings or seeds so that only plants which survive and thrive in the dry conditions of the site neutrally are kept for the long term. After 5 years, the mix of edibles to support species will look like 10%:90%. After 15 years, 50%:50%, by year 30 arriving at the 90%:10% reversed ratio. This process mimics the natural process of pulsing, succession and maturation in nature: a fire or some such disturbance clears a forest of its mature growth. This is succeeded by grasses and forbs, in turn succeeded by herbaceous perennials and shrubs, finally replaced by mature, long lived woody trees and plants.

Identifying what a mature or climax ecosystem for Moab and its environs might have looked like before European settlement is an important endeavor for the community there to engage in.

The plant list included in this report is a step in that direction, drawing from plants extant in the surrounding parks and landscapes, from histories of the area. The listed plants aim to provide a layering of trees, shrubs, and herbaceous plants as in the forest diagram to the right. They are known to thrive with each other, and have the potential to produce food for people on the limited rainfall available in the region.



FOREST GARDEN DIAGRAM - EDIBLE FOREST GARDENS, DAVE JACKE

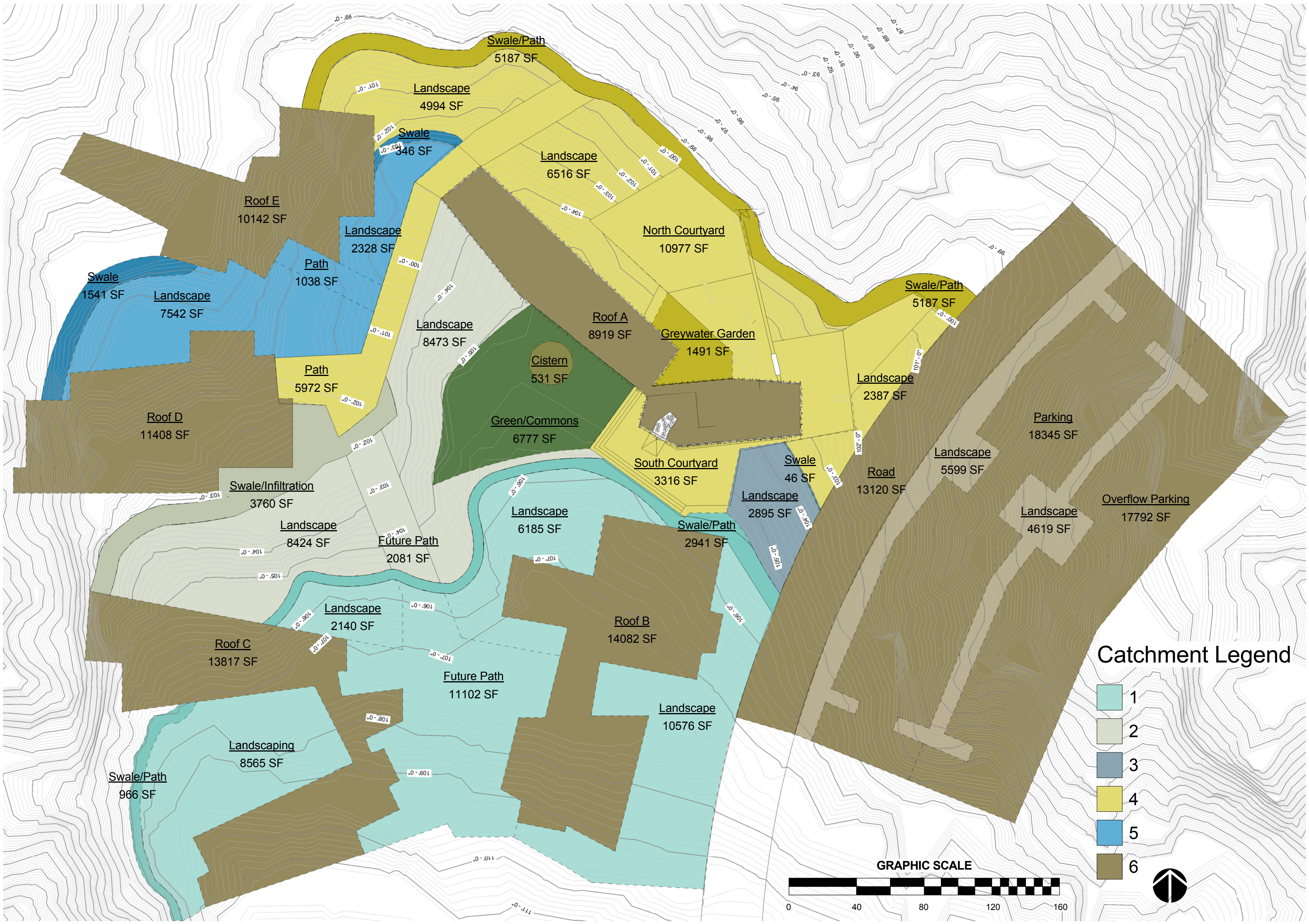
Monthly Precipitation Harvesting (Rain & Snow)

Comments	Name	Runoff Coefficient	Catchment Depth	Catchment Volume	January	January Vol	February	February Vol	March	March Vol	April	April Vol	May	May Vol	June	June Vol
Catchment 1																
Catchment 1	Future Path	90%		0.00 gal	0.67"	4173.38 gal	0.61"	3799.65 gal	0.83"	5170.01 gal	0.81"	674.48 CF	0.72"	4484.83 gal	0.43"	2678.44 gal
Catchment 1	Landscape	20%		0.00 gal	0.67"	1578.90 gal	0.61"	1437.51 gal	0.83"	1955.95 gal	0.81"	255.17 CF	0.72"	1696.73 gal	0.43"	1013.32 gal
Catchment 1	Landscaping	20%		0.00 gal	0.67"	715.46 gal	0.61"	651.39 gal	0.83"	886.32 gal	0.81"	115.63 CF	0.72"	768.86 gal	0.43"	459.18 gal
Catchment 1	Swale/Path	0%	1' - 7"	46275.92 gal	0.67"	0.00 gal	0.61"	0.00 gal	0.83"	0.00 gal	0.81"	0.00 CF	0.72"	0.00 gal	0.43"	0.00 gal
				46275.92 gal		6467.75 gal		5888.54 gal		8012.28 gal		1045.28 CF		6950.41 gal		4150.94 gal
Catchment 2																
Catchment 2	Future Path	90%		0.00 gal	0.67"	782.33 gal	0.61"	712.27 gal	0.83"	969.16 gal	0.81"	126.44 CF	0.72"	840.72 gal	0.43"	502.09 gal
Catchment 2	Green/Commons	5%		0.00 gal	0.67"	141.52 gal	0.61"	128.85 gal	0.83"	175.31 gal	0.81"	22.87 CF	0.72"	152.08 gal	0.43"	90.83 gal
Catchment 2	Landscape	20%		0.00 gal	0.67"	1411.40 gal	0.61"	1285.00 gal	0.83"	1748.45 gal	0.81"	228.10 CF	0.72"	1516.73 gal	0.43"	905.82 gal
Catchment 2	Swale/Infiltration	0%	9"	21095.17 gal	0.67"	0.00 gal	0.61"	0.00 gal	0.83"	0.00 gal	0.81"	0.00 CF	0.72"	0.00 gal	0.43"	0.00 gal
				21095.17 gal		2335.25 gal		2126.12 gal		2892.92 gal		377.41 CF		2509.52 gal		1498.74 gal
Catchment 3																
Catchment 3	Landscape	20%		0.00 gal	0.67"	241.84 gal	0.61"	220.18 gal	0.83"	299.60 gal	0.81"	39.08 CF	0.72"	259.89 gal	0.43"	155.21 gal
Catchment 3	Swale	0%	1' - 0"	342.15 gal	0.67"	0.00 gal	0.61"	0.00 gal	0.83"	0.00 gal	0.81"	0.00 CF	0.72"	0.00 gal	0.43"	0.00 gal
				342.15 gal		241.84 gal		220.18 gal		299.60 gal		39.08 CF		259.89 gal		155.21 gal
Catchment 4																
Catchment 4	Greywater Garden	0%	3"	2789.02 gal	0.67"	0.00 gal	0.61"	0.00 gal	0.83"	0.00 gal	0.81"	0.00 CF	0.72"	0.00 gal	0.43"	0.00 gal
Catchment 4	Landscape	20%		0.00 gal	0.67"	1160.89 gal	0.61"	1056.93 gal	0.83"	1438.12 gal	0.81"	187.62 CF	0.72"	1247.53 gal	0.43"	745.05 gal
Catchment 4	North Courtyard	20%		0.00 gal	0.67"	916.96 gal	0.61"	834.85 gal	0.83"	1135.94 gal	0.81"	148.19 CF	0.72"	985.39 gal	0.43"	588.50 gal
Catchment 4	Path	90%		0.00 gal	0.67"	2244.94 gal	0.61"	2043.90 gal	0.83"	2781.04 gal	0.81"	362.81 CF	0.72"	2412.47 gal	0.43"	1440.78 gal
Catchment 4	South Courtyard	90%		0.00 gal	0.67"	1246.38 gal	0.61"	1134.77 gal	0.83"	1544.03 gal	0.81"	201.43 CF	0.72"	1339.40 gal	0.43"	799.92 gal
Catchment 4	Swale/Path	0%	1' - 0"	38801.39 gal	0.67"	0.00 gal	0.61"	0.00 gal	0.83"	0.00 gal	0.81"	0.00 CF	0.72"	0.00 gal	0.43"	0.00 gal
				41590.41 gal		5569.18 gal		5070.44 gal		6899.13 gal		900.06 CF		5984.79 gal		3574.25 gal
Catchment 5																
Catchment 5	Landscape	20%		0.00 gal	0.67"	824.47 gal	0.61"	750.64 gal	0.83"	1021.36 gal	0.81"	133.25 CF	0.72"	886.00 gal	0.43"	529.14 gal
Catchment 5	Path	90%		0.00 gal	0.67"	390.11 gal	0.61"	355.18 gal	0.83"	483.27 gal	0.81"	63.05 CF	0.72"	419.22 gal	0.43"	250.37 gal
Catchment 5	Swale	0%	1' - 0"	14119.82 gal	0.67"	0.00 gal	0.61"	0.00 gal	0.83"	0.00 gal	0.81"	0.00 CF	0.72"	0.00 gal	0.43"	0.00 gal
				14119.82 gal		1214.58 gal		1105.81 gal		1504.63 gal		196.29 CF		1305.22 gal		779.51 gal
Catchment 6																
Catchment 6	Landscape	20%		0.00 gal	0.67"	853.53 gal	0.61"	777.10 gal	0.83"	1057.36 gal	0.81"	137.94 CF	0.72"	917.23 gal	0.43"	547.79 gal
Catchment 6	Overflow Parking	60%		0.00 gal	0.67"	4458.72 gal	0.61"	4059.43 gal	0.83"	5523.48 gal	0.81"	720.59 CF	0.72"	4791.46 gal	0.43"	2861.56 gal
Catchment 6	Parking	90%		0.00 gal	0.67"	6895.87 gal	0.61"	6278.33 gal	0.83"	8542.65 gal	0.81"	1114.47 CF	0.72"	7410.49 gal	0.43"	4425.71 gal
Catchment 6	Road			0.00 gal		0.00 gal		0.00 gal		0.00 gal		0.00 CF		0.00 gal		0.00 gal
				0.00 gal		12208.12 gal		11114.86 gal		15123.49 gal		1973.00 CF		13119.17 gal		7835.06 gal
Roof Catchment																
Roof Catchment	Cistern	0%	10' - 0"	39716.26 gal	0.67"	0.00 gal	0.61"	0.00 gal	0.83"	0.00 gal	0.81"	0.00 CF	0.72"	0.00 gal	0.43"	0.00 gal
Roof Catchment	Roof A	90%		0.00 gal	0.67"	3352.52 gal	0.61"	3052.30 gal	0.83"	4153.13 gal	0.81"	541.81 CF	0.72"	3602.71 gal	0.43"	2151.62 gal
Roof Catchment	Roof B	90%		0.00 gal	0.67"	5293.53 gal	0.61"	4819.48 gal	0.83"	6557.65 gal	0.81"	855.51 CF	0.72"	5688.57 gal	0.43"	3397.34 gal
Roof Catchment	Roof C	90%		0.00 gal	0.67"	5193.92 gal	0.61"	4728.80 gal	0.83"	6434.26 gal	0.81"	839.41 CF	0.72"	5581.53 gal	0.43"	3333.41 gal
Roof Catchment	Roof D	90%		0.00 gal	0.67"	4288.20 gal	0.61"	3904.18 gal	0.83"	5312.25 gal	0.81"	693.03 CF	0.72"	4608.21 gal	0.43"	2752.13 gal
Roof Catchment	Roof E	90%		0.00 gal	0.67"	3812.35 gal	0.61"	3470.95 gal	0.83"	4722.76 gal	0.81"	616.13 CF	0.72"	4096.85 gal	0.43"	2446.73 gal
				39716.26 gal		21940.52 gal		19975.70 gal		27180.05 gal		3545.89 CF		23577.87 gal		14081.23 gal
Grand total				163139.72 gal		49977.23 gal		45501.66 gal		61912.09 gal		8077.01 CF		53706.88 gal		32074.94 gal

RAINWATER HARVESTING CALCULATIONS

The rainwater harvesting estimations and storm water runoff calculations used to evaluate the feasibility of the turf commons, the quantity of landscaping that could be sustained by rainwater alone, and the size of the rainwater harvesting swales to mitigate storm water quantity and quality runoff, are included at left and are accompanied by a campus node site plan and legend on the following page.

July	July Vol	August	August Vol	September	September Vol	October	October Vol	November	November Vol	December	December Vol
0.78"	4858.57 gal	0.86"	5356.88 gal	0.85"	5294.59 gal	1.01"	6291.22 gal	0.70"	4360.25 gal	0.75"	4671.70 gal
0.78"	1838.12 gal	0.86"	2026.65 gal	0.85"	2003.08 gal	1.01"	2380.13 gal	0.70"	1649.60 gal	0.75"	1767.42 gal
0.78"	832.93 gal	0.86"	918.35 gal	0.85"	907.68 gal	1.01"	1078.53 gal	0.70"	747.50 gal	0.75"	800.89 gal
0.78"	0.00 gal	0.86"	0.00 gal	0.85"	0.00 gal	1.01"	0.00 gal	0.70"	0.00 gal	0.75"	0.00 gal
	7529.61 gal		8301.88 gal		8205.35 gal		9749.89 gal		6757.35 gal		7240.01 gal
0.78"	910.77 gal	0.86"	1004.19 gal	0.85"	992.51 gal	1.01"	1179.34 gal	0.70"	817.36 gal	0.75"	875.75 gal
0.78"	164.75 gal	0.86"	181.65 gal	0.85"	179.54 gal	1.01"	213.33 gal	0.70"	147.86 gal	0.75"	158.42 gal
0.78"	1643.12 gal	0.86"	1811.64 gal	0.85"	1790.58 gal	1.01"	2127.63 gal	0.70"	1474.59 gal	0.75"	1579.92 gal
0.78"	0.00 gal	0.86"	0.00 gal	0.85"	0.00 gal	1.01"	0.00 gal	0.70"	0.00 gal	0.75"	0.00 gal
	2718.65 gal		2997.48 gal		2962.63 gal		3520.30 gal		2439.81 gal		2614.08 gal
0.78"	281.55 gal	0.86"	310.42 gal	0.85"	306.81 gal	1.01"	364.57 gal	0.70"	252.67 gal	0.75"	270.72 gal
0.78"	0.00 gal	0.86"	0.00 gal	0.85"	0.00 gal	1.01"	0.00 gal	0.70"	0.00 gal	0.75"	0.00 gal
	281.55 gal		310.42 gal		306.81 gal		364.57 gal		252.67 gal		270.72 gal
0.78"	0.00 gal	0.86"	0.00 gal	0.85"	0.00 gal	1.01"	0.00 gal	0.70"	0.00 gal	0.75"	0.00 gal
0.78"	1351.49 gal	0.86"	1490.10 gal	0.85"	1472.77 gal	1.01"	1750.00 gal	0.70"	1212.87 gal	0.75"	1299.51 gal
0.78"	1067.51 gal	0.86"	1177.00 gal	0.85"	1163.31 gal	1.01"	1382.29 gal	0.70"	958.02 gal	0.75"	1026.45 gal
0.78"	2613.51 gal	0.86"	2881.56 gal	0.85"	2848.05 gal	1.01"	3384.16 gal	0.70"	2345.46 gal	0.75"	2512.99 gal
0.78"	1451.02 gal	0.86"	1599.84 gal	0.85"	1581.23 gal	1.01"	1878.88 gal	0.70"	1302.19 gal	0.75"	1395.21 gal
0.78"	0.00 gal	0.86"	0.00 gal	0.85"	0.00 gal	1.01"	0.00 gal	0.70"	0.00 gal	0.75"	0.00 gal
	6483.52 gal		7148.49 gal		7065.37 gal		8395.32 gal		5818.54 gal		6234.15 gal
0.78"	959.83 gal	0.86"	1058.27 gal	0.85"	1045.97 gal	1.01"	1242.86 gal	0.70"	861.39 gal	0.75"	922.91 gal
0.78"	454.16 gal	0.86"	500.74 gal	0.85"	494.92 gal	1.01"	588.08 gal	0.70"	407.58 gal	0.75"	436.69 gal
0.78"	0.00 gal	0.86"	0.00 gal	0.85"	0.00 gal	1.01"	0.00 gal	0.70"	0.00 gal	0.75"	0.00 gal
	1413.99 gal		1559.01 gal		1540.88 gal		1830.93 gal		1268.96 gal		1359.60 gal
0.78"	993.66 gal	0.86"	1095.58 gal	0.85"	1082.84 gal	1.01"	1286.67 gal	0.70"	891.75 gal	0.75"	955.45 gal
0.78"	5190.74 gal	0.86"	5723.13 gal	0.85"	5656.58 gal	1.01"	6721.35 gal	0.70"	4658.36 gal	0.75"	4991.10 gal
0.78"	8028.03 gal	0.86"	8851.42 gal	0.85"	8748.50 gal	1.01"	10395.27 gal	0.70"	7204.64 gal	0.75"	7719.26 gal
	0.00 gal		0.00 gal		0.00 gal		0.00 gal		0.00 gal		0.00 gal
	14212.44 gal		15670.12 gal		15487.91 gal		18403.29 gal		12754.75 gal		13665.81 gal
0.78"	0.00 gal	0.86"	0.00 gal	0.85"	0.00 gal	1.01"	0.00 gal	0.70"	0.00 gal	0.75"	0.00 gal
0.78"	3902.94 gal	0.86"	4303.24 gal	0.85"	4253.20 gal	1.01"	5053.80 gal	0.70"	3502.64 gal	0.75"	3752.82 gal
0.78"	6162.61 gal	0.86"	6794.68 gal	0.85"	6715.67 gal	1.01"	7979.79 gal	0.70"	5530.55 gal	0.75"	5925.59 gal
0.78"	6046.66 gal	0.86"	6666.83 gal	0.85"	6589.31 gal	1.01"	7829.65 gal	0.70"	5426.49 gal	0.75"	5814.09 gal
0.78"	4992.23 gal	0.86"	5504.25 gal	0.85"	5440.25 gal	1.01"	6464.30 gal	0.70"	4480.21 gal	0.75"	4800.22 gal
0.78"	4438.26 gal	0.86"	4893.46 gal	0.85"	4836.56 gal	1.01"	5746.98 gal	0.70"	3983.05 gal	0.75"	4267.56 gal
	25542.70 gal		28162.46 gal		27834.99 gal		33074.52 gal		22922.93 gal		24560.28 gal
	58182.45 gal		64149.88 gal		63403.95 gal		75338.81 gal		52215.02 gal		55944.66 gal



CAMPUS NODE STORM WATER ANALYSIS PLAN

08.

COST ANALYSIS

Detailed Estimate

PROJECT ESTIMATE

A significant effort was made during the process to evaluate and track the project budget, balancing it with the project needs and goals. The initial project budget was identified at $6-7 million. After a 20% reduction for soft costs from &6,000,000 the initial working budget became $4,800,000 for the building cost. After developing the plan to meet the requirements of the space lists and the project goals, the project construction estimate came in at $5,882,263. This would put the total project cost at $7,352,828 including soft costs, which USU Moab accepted as a feasible project cost.

PROJECT ESTIMATE — **CONSTRUCTION CONTROL CORPORATION** — **10/17/2014**

PROJECT NAME..............USU MOAB
LOCATION.......................MOAB, UT
ARCHITECT.....................EDA
STAGE OF DESIGN..........FEASIBILITY

PROJECT SIZE 16,448 SF

CSI #	DESCRIPTION	UNIT QTY	UNIT COST	TOTAL
	BUILDING COST SUMMARY			
02	SITEWORK & DEMOLITION		$ 55.81	$ 917,917
03	CONCRETE		$ 11.23	$ 184,661
04	MASONRY		$ -	$ -
05	METALS		$ 23.50	$ 386,507
06	WOODS & PLASTICS		$ 4.81	$ 79,153
07	THERMAL & MOISTURE PROTECTION		$ 41.47	$ 682,026
08	DOORS & WINDOWS		$ 16.13	$ 265,359
09	FINISHES		$ 30.27	$ 497,850
10	SPECIALTIES		$ 3.45	$ 56,746
11	EQUIPMENT		$ 2.10	$ 34,500
12	FURNISHINGS		$ -	$ -
13	SPECIAL CONSTRUCTION		$ 10.49	$ 172,500
14	CONVEYING SYSTEMS		$ 3.85	$ 63,250
15	MECHANICAL		$ 50.83	$ 836,026
16	ELECTRICAL		$ 29.91	$ 491,967
	SUBTOTAL		$ 283.83	$ 4,668,463
	GENERAL CONDITIONS	7%	$ 19.87	$ 326,792
	OVERHEAD & PROFIT	4%	$ 11.35	$ 186,739
	DESIGN CONTINGENCY	15%	$ 42.57	$ 700,269
	TOTAL CONSTRUCTION COST		$ 357.63	$ 5,882,263
	PARKING OPTION (15,312 SF)			$ 29,055

PROJECT ESTIMATE	CONSTRUCTION CONTROL CORPORATION			10/17/2014

PROJECT NAME…………..USU MOAB
LOCATION………………….MOAB, UT
ARCHITECT…………………EDA
STAGE OF DESIGN……….FEASIBILITY

PROJECT SIZE 16,448 SF

CSI #	DESCRIPTION	UNIT QTY	UNIT COST	TOTAL
02	**SITEWORK & DEMOLITION**			
	Demolition			
	Subtotal for Demolition			**$ -**
	Earthwork			
	Site Clearing	100000 SF	$ 0.45	$ 44,850
	Site Excavation	10000 CY	$ 4.03	$ 40,250
	Site Fill	10000 CY	$ 6.50	$ 64,975
	Building Excavation	943 CY	$ 5.75	$ 5,425
	Compacted Backfill	943 CY	$ 14.38	$ 13,556
	Site Grading	100000 SF	$ 0.36	$ 35,650
	Building Grading	8491 SF	$ 0.36	$ 3,027
	Gravel Under Slab	176 Ton	$ 27.60	$ 4,869
	SWPPP	1 LS	$ 8,050.00	$ 8,050
	Subtotal for Earthwork			**$ 220,652**
	Site Utilities			
	Water Utility	1 LS	$ 5,750.00	$ 5,750
	Fire Line	1 LS	$ 11,500.00	$ 11,500
	Sewer Utility	1 LS	$ 23,000.00	$ 23,000
	Storm Drain - Included w/ Site Improvements			
	Subtotal for Site Utilities			**$ 40,250**
	Site Improvements			
	Retaining Wall Footing	18 CY	$ 350.75	$ 6,314
	Retaining Wall	3689 SF	$ 28.38	$ 104,701
	Water Channel	100 LF	$ 16.33	$ 1,633
	Parking Area - Asphalt	18345 SF	$ 1.90	$ 34,810
	Gravel Overflow	17792 SF	$ 1.44	$ 25,576
	Landscaped Area	25800 SF	$ 6.33	$ 163,185
	Swale/Path	5300 SF	$ 5.18	$ 27,428
	North Courtyard - Exposed Aggregate Concrete	17924 SF	$ 9.98	$ 178,917
	Seatwall	300 LF	$ 120.00	$ 36,000
	Garden Landscape	6700 SF	$ 6.25	$ 41,875
	Trees	42 LS	$ 300.00	$ 12,600
	Cistern - 6000 Gal.	1 EA	$ 9,027.50	$ 9,028
	Sculpted Bench	2 EA	$ 5,175.00	$ 10,350
	Steel Bridge	1 EA	$ 2,875.00	$ 2,875
	Bike Rack	1 LS	$ 1,725.00	$ 1,725
	Subtotal for Site Improvements			**$ 657,016**
	TOTAL SITEWORK & DEMOLITION			**$ 917,917**
03	**CONCRETE**			
	Continuous Footing	118 CY	$ 350.75	$ 41,389
	Spot Footing	60 CY	$ 362.25	$ 21,735
	Foundation Wall	2443 SF	$ 22.63	$ 55,290
	Slab on Grade	8683 SF	$ 4.08	$ 35,448
	Topping Slab	7652 SF	$ 4.03	$ 30,799
	TOTAL CONCRETE			**$ 184,661**
04	**MASONRY**			
	TOTAL MASONRY			**$ -**
05	**METALS**			
	Floor Structure (11 LB/SF)	84172 LB	$ 1.90	$ 159,716
	Roof Structure (8 LB/SF)	69464 LB	$ 1.90	$ 131,808
	Floor Deck	7652 SF	$ 3.39	$ 25,959
	Roof Deck	8683 SF	$ 3.39	$ 29,457
	Metal Pan Stairs	300 SF	$ 60.95	$ 18,285
	Decorative Freestanding Rail	71 LF	$ 178.25	$ 12,656

PROJECT ESTIMATE	CONSTRUCTION CONTROL CORPORATION			10/17/2014
	PROJECT NAME……………USU MOAB			
	LOCATION…………………MOAB, UT			
	ARCHITECT…………………EDA	PROJECT SIZE	16,448	SF
	STAGE OF DESIGN……….FEASIBILITY			

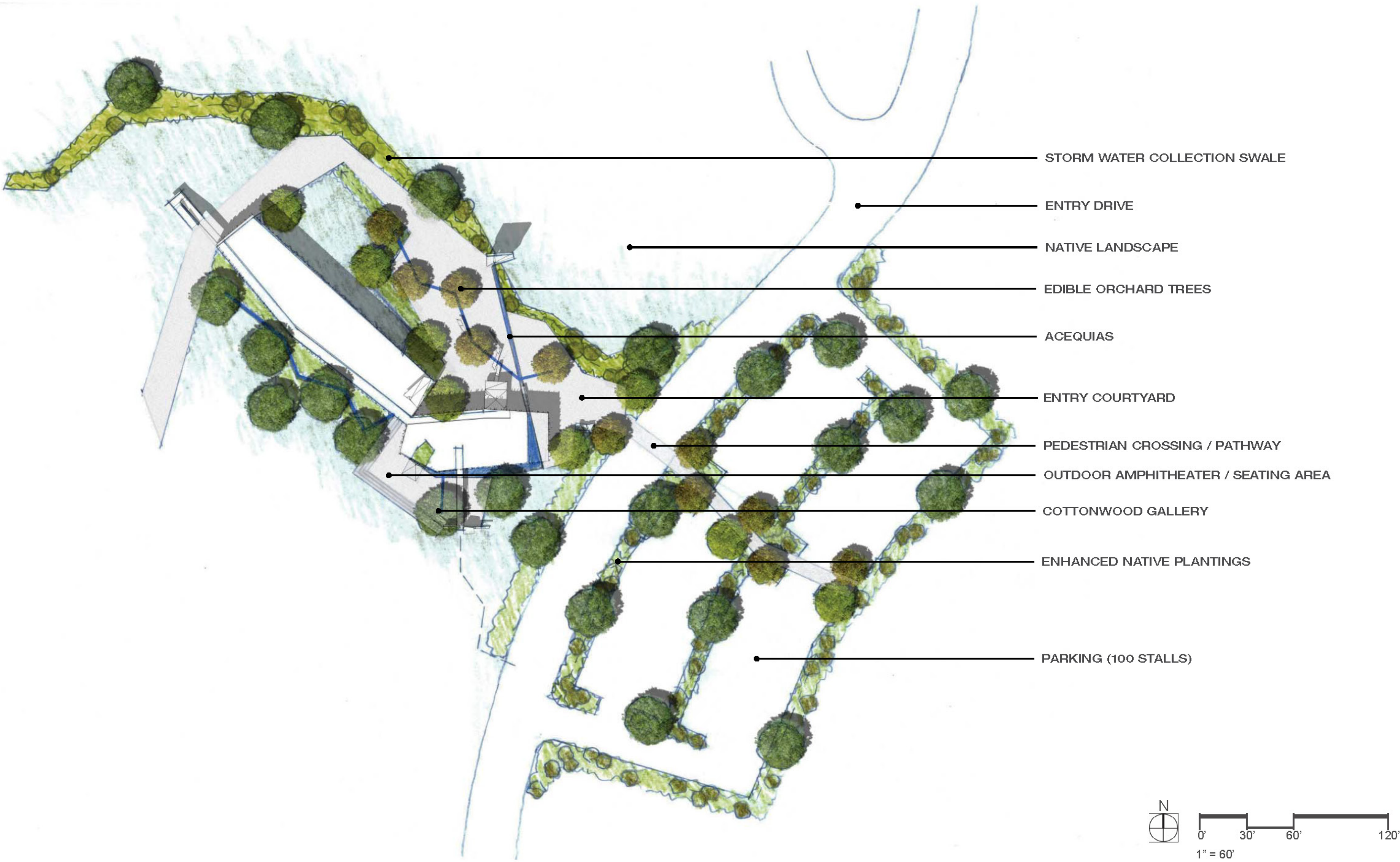
CSI #	DESCRIPTION	UNIT QTY	UNIT COST	TOTAL
	Freestanding Rail	60 LF	$ 143.75	$ 8,625
	TOTAL METALS			**$ 386,507**
06	**WOOD & PLASTICS**			
	Carpentry			
	Wood Plates & Blocking	16448 SF	$ 0.29	$ 4,729
	Subtotal for Carpentry			**$ 4,729**
	Millwork			
	General Building Millwork	15,607 SF	$ 4.03	$ 62,818
	Lab Millwork	841 SF	$ 13.80	$ 11,606
	Subtotal for Millwork			**$ 74,424**
	TOTAL WOOD & PLASTICS			**$ 79,153**
07	**THERMAL & MOISTURE PROTECTION**			
	Foundation Insulation	2431 SF	$ 1.67	$ 4,054
	Rigid Wall Insulation	10566 SF	$ 1.90	$ 20,049
	Weather Barrier	10566 SF	$ 3.16	$ 33,415
	R-19 Wall Insulation	10566 SF	$ 0.75	$ 7,899
	Sound Batt	19061 SF	$ 0.51	$ 9,645
	Rigid Roof Insulation	8736 SF	$ 3.16	$ 27,628
	Roof Membrane	8736 SF	$ 3.16	$ 27,628
	Metal Siding	10566 SF	$ 22.00	$ 232,452
	Shading Devices	11835 SF	$ 23.00	$ 272,205
	Metal Wall Cap	587 LF	$ 14.55	$ 8,539
	Flashing & Sheet Metal	1174 SF	$ 8.80	$ 10,328
	Fireproofing	16448 SF	$ 1.14	$ 18,726
	Caulking & Sealing	16448 SF	$ 0.58	$ 9,458
	TOTAL THERMAL & MOISTURE PROTECTION			**$ 682,026**
08	**DOORS & WINDOWS**			
	Single Interior Door	47 EA	$ 1,322.50	$ 62,158
	Single Exterior Door	4 EA	$ 3,047.50	$ 12,190
	Exterior Glazing (25% of Exterior)	3522 SF	$ 44.28	$ 155,937
	Interior Glazing	1000 SF	$ 35.08	$ 35,075
	TOTAL DOORS & WINDOWS			**$ 265,359**
09	**FINISHES**			
	Exterior Metal Stud Wall	14088 SF	$ 4.60	$ 64,805
	Interior Partition Wall	19061 SF	$ 2.59	$ 49,320
	Interior Furring Wall	1494 SF	$ 2.13	$ 3,178
	Shaftwall	1500 SF	$ 8.80	$ 13,196
	Gyp. Wallboard	53704 SF	$ 1.51	$ 80,905
	Ceilings	16448 SF	$ 4.89	$ 80,390
	Stained Concrete Floor	4539 SF	$ 5.18	$ 23,489
	Remaining Flooring	11909 SF	$ 4.60	$ 54,781
	Base	3922 LF	$ 3.74	$ 14,658
	Wall Coverings	53704 SF	$ 1.44	$ 77,200
	Paint Gyp. Wallboard	53704 SF	$ 0.60	$ 32,115
	Paint/Stain Doors & Frames	51 Leaf	$ 74.75	$ 3,812
	TOTAL FINISHES			**$ 497,850**
10	**SPECIALTIES**	16448 SF	$ 3.45	**$ 56,746**
11	**EQUIPMENT**			
	Dry Lab Equipment	1 LS	$ 17,250.00	$ 17,250

PROJECT ESTIMATE	CONSTRUCTION CONTROL CORPORATION			10/17/2014
PROJECT NAME…………..USU MOAB				
LOCATION……………..…….MOAB, UT				
ARCHITECT…….…………EDA		PROJECT SIZE	16,448	SF
STAGE OF DESIGN……….FEASIBILITY				

CSI #	DESCRIPTION	UNIT QTY	UNIT COST	TOTAL
	Wet Lab Equipment	1 LS	$ 17,250.00	$ 17,250
	TOTAL EQUIPMENT			**$ 34,500**
12	**FURNISHINGS**			
	TOTAL EQUIPMENT			**$ -**
13	**SPECIAL CONSTRUCTION**			
	Concrete Site Sculptural Elements	1 LS	$ 115,000.00	$ 115,000
	Formed Concrete Entry Canopy	2 EA	$ 28,750.00	$ 57,500
	TOTAL SPECIAL CONSTRUCTION			**$ 172,500**
14	**CONVEYING SYSTEMS**			
	2 Stop Elevator	1 EA	$ 63,250.00	$ 63,250
	TOTAL CONVEYING SYSTEMS			**$ 63,250**
15	**MECHANICAL**			
	HVAC - Ground Source Heat Pump, Radiant Floor	15607 SF	$ 36.80	**$ 574,338**
	Lab HVAC	841 SF	$ 86.25	**$ 72,536**
	Fire Protection	16448 SF	$ 3.45	**$ 56,746**
	Plumbing w/ Separate Gray Water Piping	16448 SF	$ 8.05	**$ 132,406**
	TOTAL MECHANICAL			**$ 836,026**
16	**ELECTRICAL**			
	Service & Distribution	16448 SF	$ 5.35	**$ 87,956**
	Power	16448 SF	$ 4.31	**$ 70,932**
	Lighting	16448 SF	$ 8.05	**$ 132,406**
	Photovoltaics	1 LS	$ 14,550.00	**$ 14,550**
	Site Lighting	1 LS	$ 57,500.00	**$ 57,500**
	Telecommunication System	16448 SF	$ 2.01	**$ 33,102**
	Fire/Smoke System	16448 SF	$ 2.36	**$ 38,776**
	Special Systems	16448 SF	$ 3.45	**$ 56,746**
	TOTAL ELECTRICAL			**$ 491,967**

09.

APPENDIX



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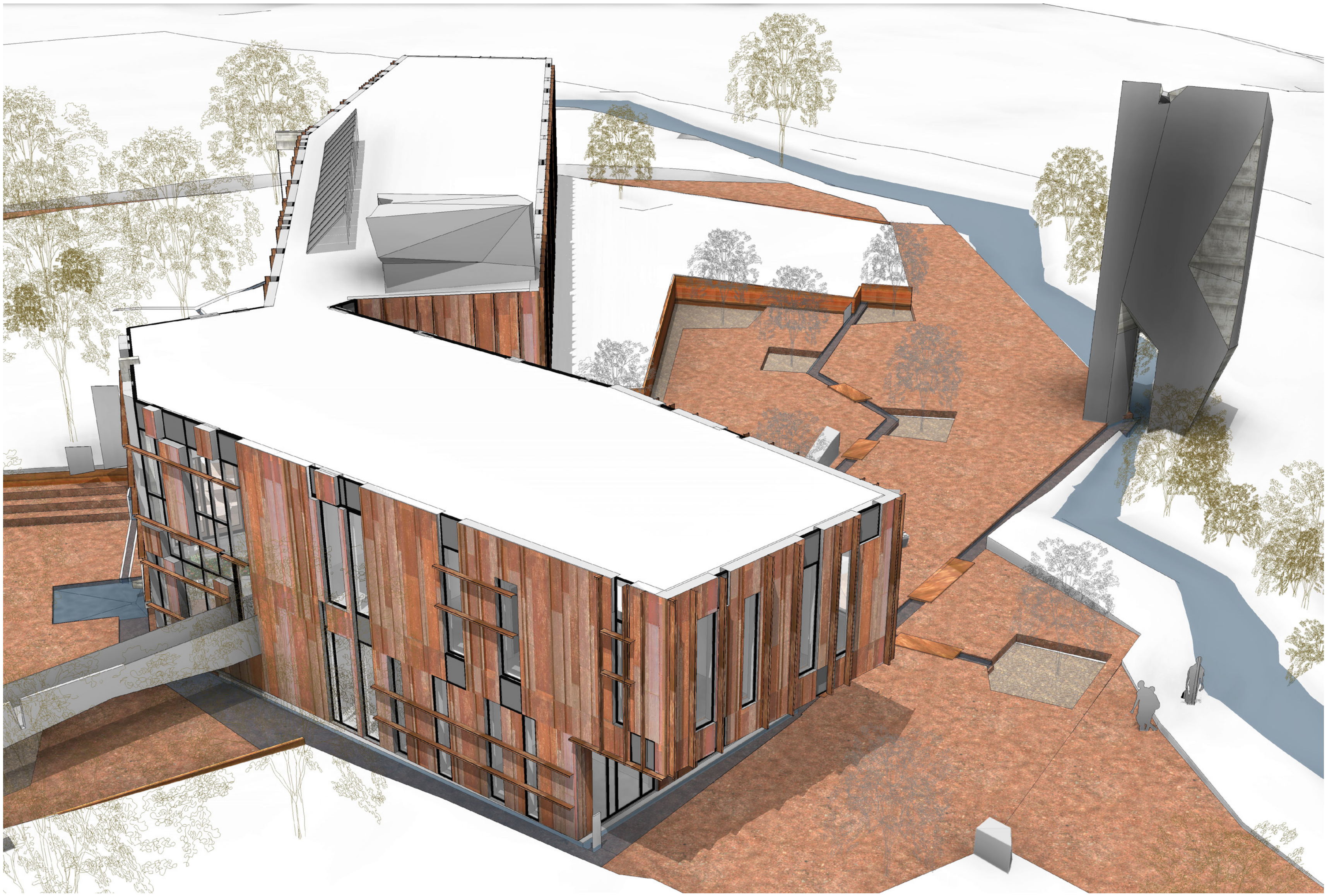

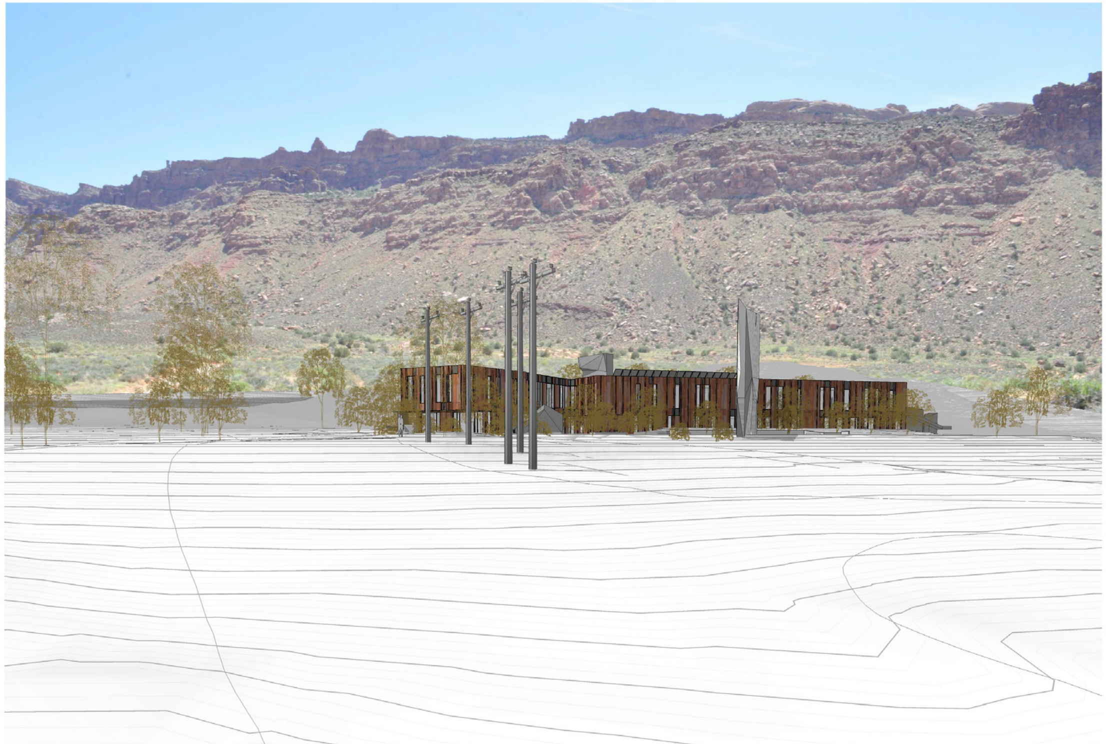

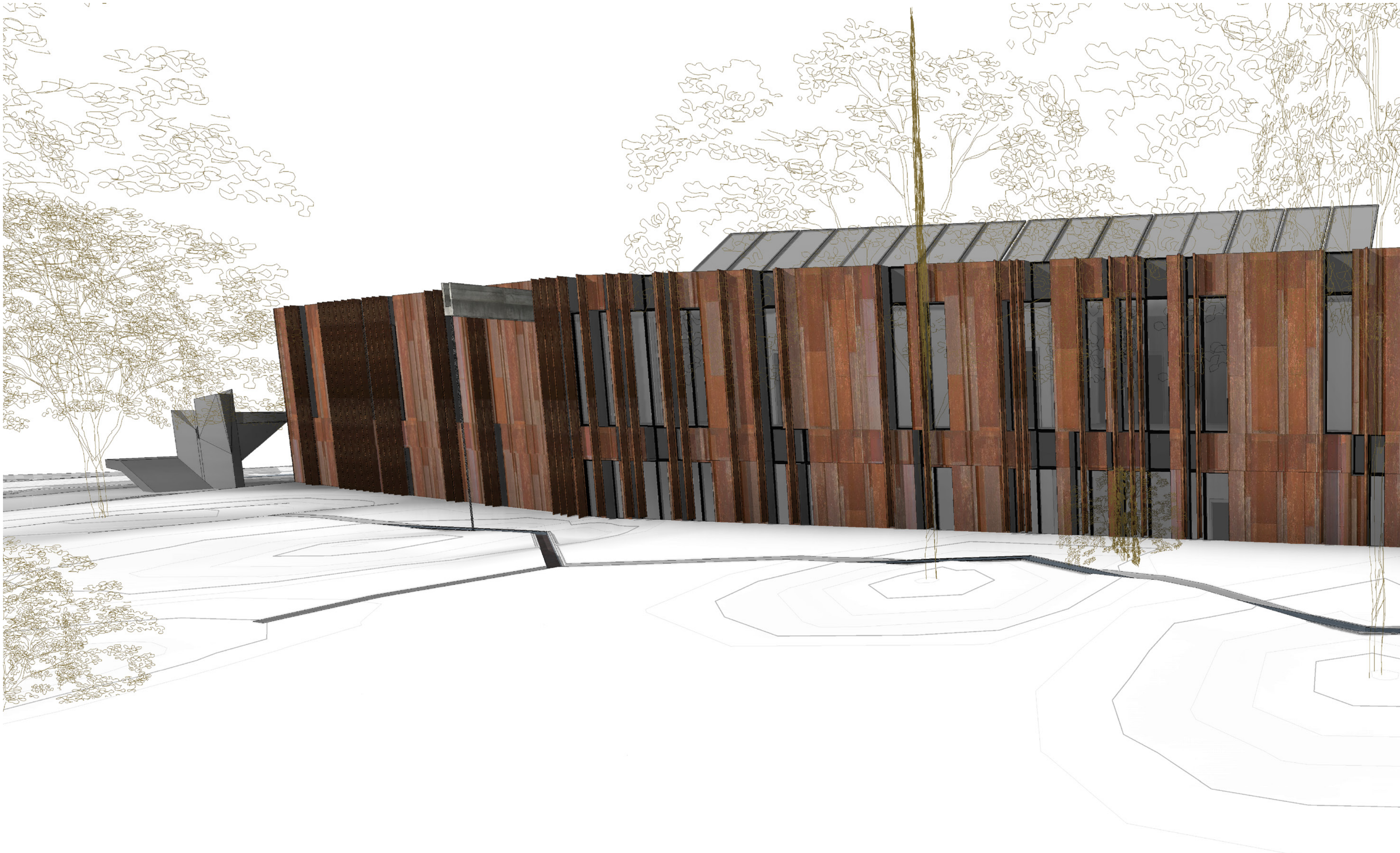

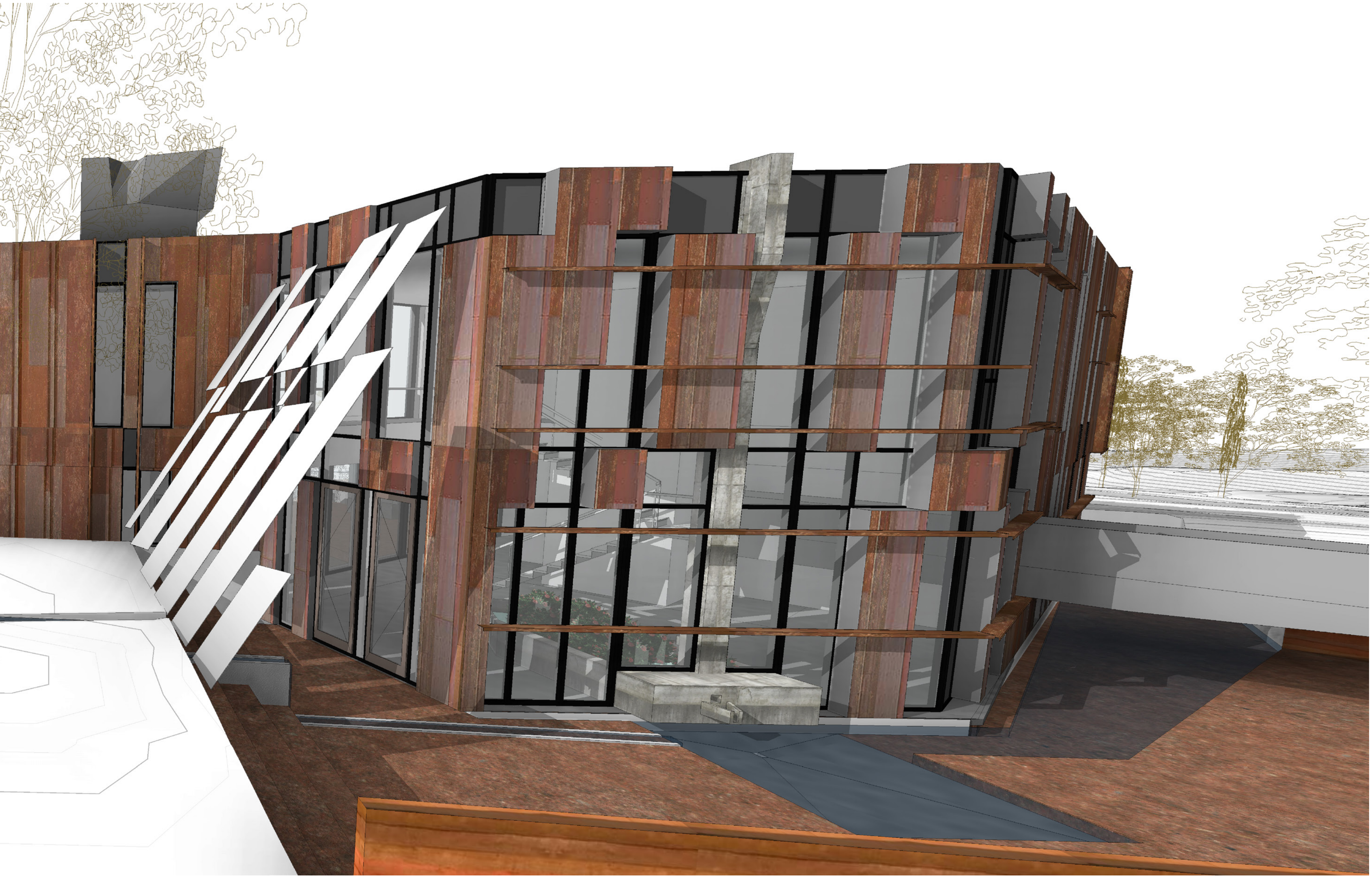

Goal: Innovative, efficient, life cycle cost effective and flexible means to provide HVAC to an expanding campus

	Option 1				Option 2	
	Initial Phase	**Long Term (> 3 Buildings)**			**100% Ground Source**	**Hybrid**
	Individual boiler/chiller at each building	**Central Chilled Water Plant, Central Boilers**	**Central Chilled Water Plant, Local Boilers**	**Multiple Chiller/Boiler Plants**	**Central Condenser Water Loop**	**Central Condenser Water Loop, Cooling Tower**
Description	Air-cooled chillers and modular condensing boilers at each building.	Water-cooled chillers in a central plant building, designed for current and near-term load, with expansion capability. Steam boilers in plant and steam converter at each building. Distribution via tunnel.	Water-cooled chillers in a central plant building, designed for current and near-term load, with expansion capability. Individual condensing boilers in each building Distribution via tunnel	Chiller and boiler plant located in the first building of a cluster. Utilities distributed throughout cluster, and between clusters.	Two-pipe condenser loop with heat pumps at each building. Ground coupled heat source/sink	Two-pipe condenser loop with heat pumps at each building. Ground coupled heat source/sink Cooling tower rejects extra heat, allowing ground loop to be approximately 30% smaller
First Cost	Highest per building, but lowest "sunk" cost	High initial cost for plant and distribution Lower marginal cost, but provisions needed to allocate plant additions	High initial cost for plant and distribution Lower marginal cost, but provisions needed to allocate plant additions	The first building in a cluster incurs a large cost, then each remaining building is low (depending on size of initial boiler/chiller plant)	Ground-coupled system is initially expensive, but it is readily expandable Each building requires heat pumps and a dedicated outside air handler	Ground loop outside the building is approximately 25% less expensive than 100% ground source
Efficiency	Least efficient of the options Air-cooled chiller is poor efficiency	High diversity allows better chiller efficiency than individual chillers, but distribution losses can erode savings. Cooling tower at each building can reduce chilled water demand by 80% Steam boilers are low (~78%) efficiency	High diversity allows better chiller efficiency than individual chillers, but distribution losses can erode savings Cooling tower at each building can reduce chilled water demand by 80% Modular boilers are more efficient (>90%) than central steam	Diversity is less than central plant, but improved over individual boiler/chiller. Minimal distribution losses.	Very high because shared heating and cooling loads.	Very high because shared heating and cooling loads.

	Option 1				Option 2	
	Initial Phase	**Long Term (> 3 Buildings)**			**100% Ground Source**	**Hybrid**
	Individual boiler/chiller at each building	**Central Chilled Water Plant, Central Boilers**	**Central Chilled Water Plant, Local Boilers**	**Multiple Chiller/Boiler Plants**	**Central Condenser Water Loop**	**Central Condenser Water Loop, Cooling Tower**
Maintenance	Highest, because each building stands alone Air-cooled chiller is less maintenance than cooling tower	Central location optimizes maintenance. Building cooling tower requires regular maintenance	Central location optimizes maintenance. Building cooling tower requires regular maintenance Local boiler requires periodic maintenance	Multiple central plants should be only marginally more difficult to maintain than single plant	Very low maintenance – no cooling tower, no boiler	Low maintenance, but higher than 100% ground loop because of cooling tower(s)
Noise	Air-cooled chiller is very noisy	Noise is concentrated at plant, with minimal noise at building. Cooling tower can be noisy if at grade	Noise is concentrated at plant, with minimal noise at building. Boiler is not noisy, but needs to be considered. Cooling tower can be noisy if at grade	The building with boilers and chillers will be noisy, others not	Heat pumps can be noisy if not carefully designed, but are generally considered relatively quiet	Inside, same as 100% ground source. Outside, cooling tower can be noisy if at grade
Durability/ Longevity	Chiller: 15 years Boiler: 25 years	Chillers, w/o local evap cooling: 25 years Chillers, w/ local evap cooling: 40 years Boiler: 30 years Cooling Tower: 20 years	Chillers, w/o local evap cooling: 25 years Chillers, w/ local evap cooling: 40 years Boiler: 25 years Cooling Tower: 20 years	Chillers, w/o local evap cooling: 25 years Chillers, w/ local evap cooling: 40 years Boiler: 25 years Cooling Tower: 20 years	Ground coupled system: 75 years Heat recovery chillers: 25 years	Ground coupled system: 75 years Cooling Tower: 20 years
Mechanical Space	Boilers and chillers at each building Air-cooled chiller or split condensing unit at each building.	Chilled and condenser water pumps and heat exchanger at each building. Cooling tower on roof	Chilled water pumps and boiler room at each building Boiler room	Substantial room in first building, very little room in subsequent	Small pump room Small air handler, usually on roof Ground loop requires substantial area – usually under parking	Small pump room Small air handler, usually on roof Ground loop requires substantial area – usually under parking Cooling tower(s) on roof