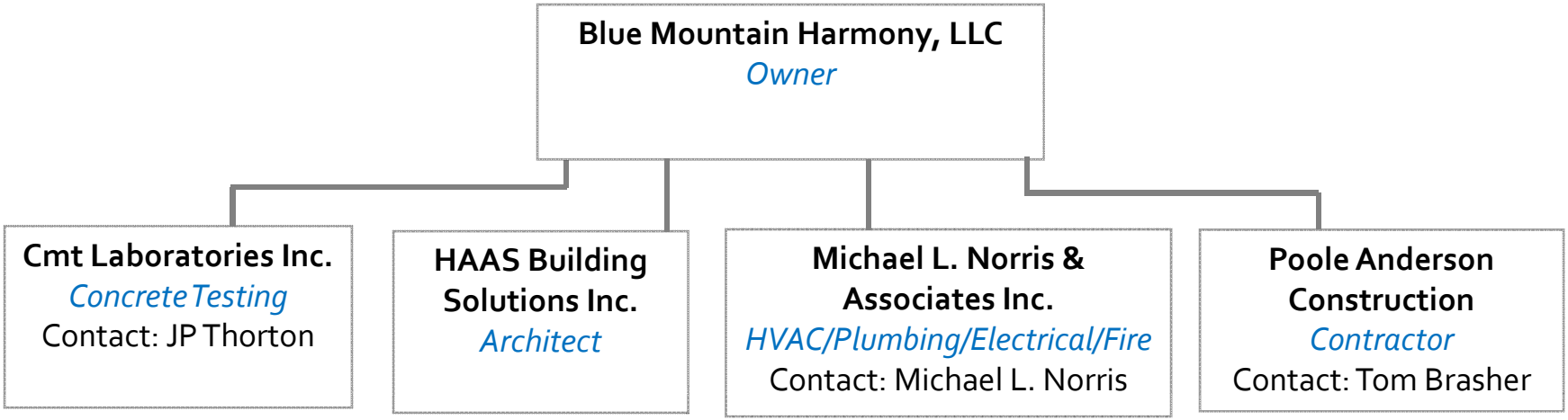
Overview

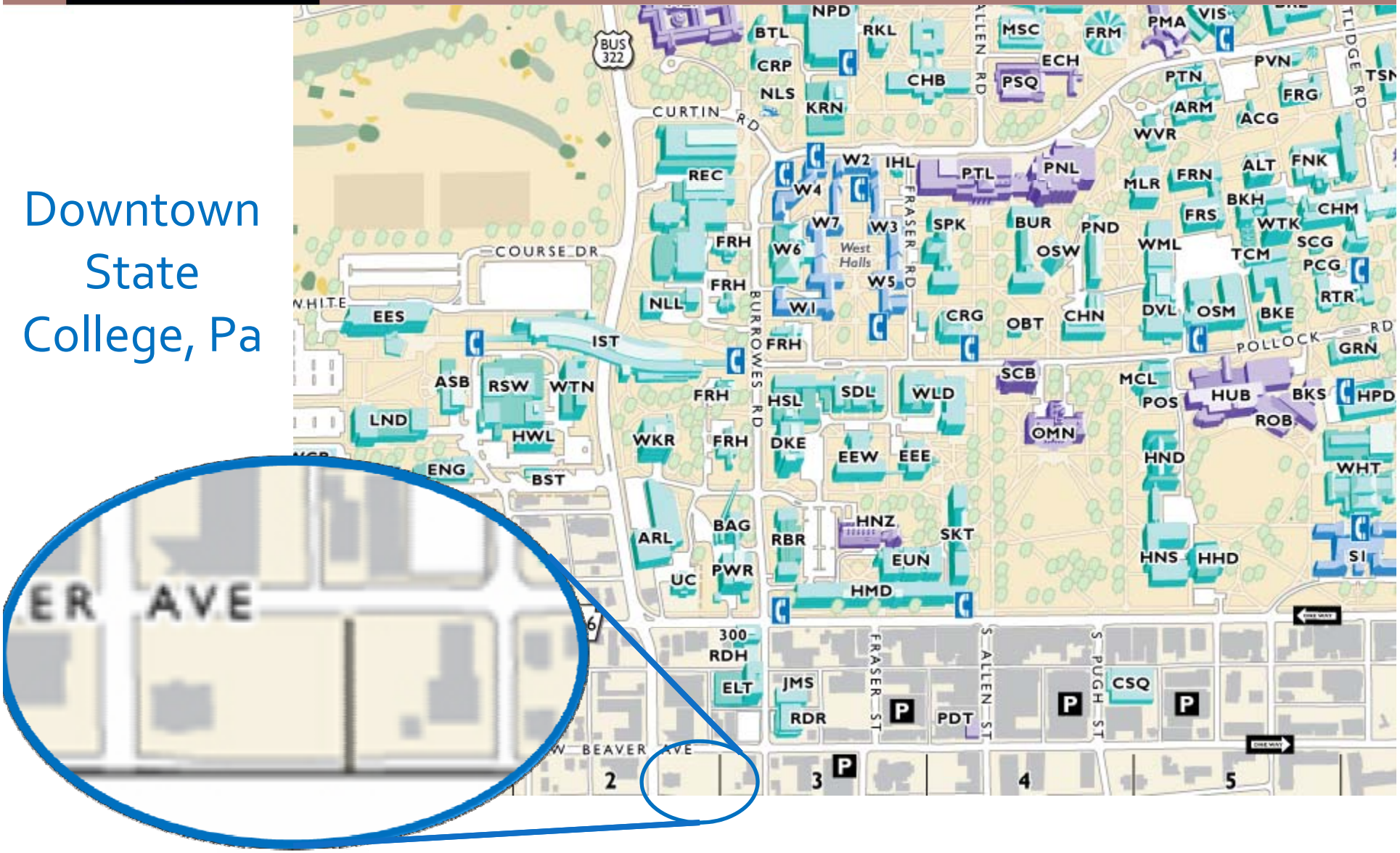
- Background: ***The Palmerton***
- Analysis 1: ***Sustainable Student Apartment Buildings***
  - ***Research***
- Analysis 2: ***Green Roof***
  - ***Structural Breadth***
- Analysis 3: ***Mechanical Redesign***
  - ***Mechanical Breadth***
- Conclusions: ***Wrap Up***

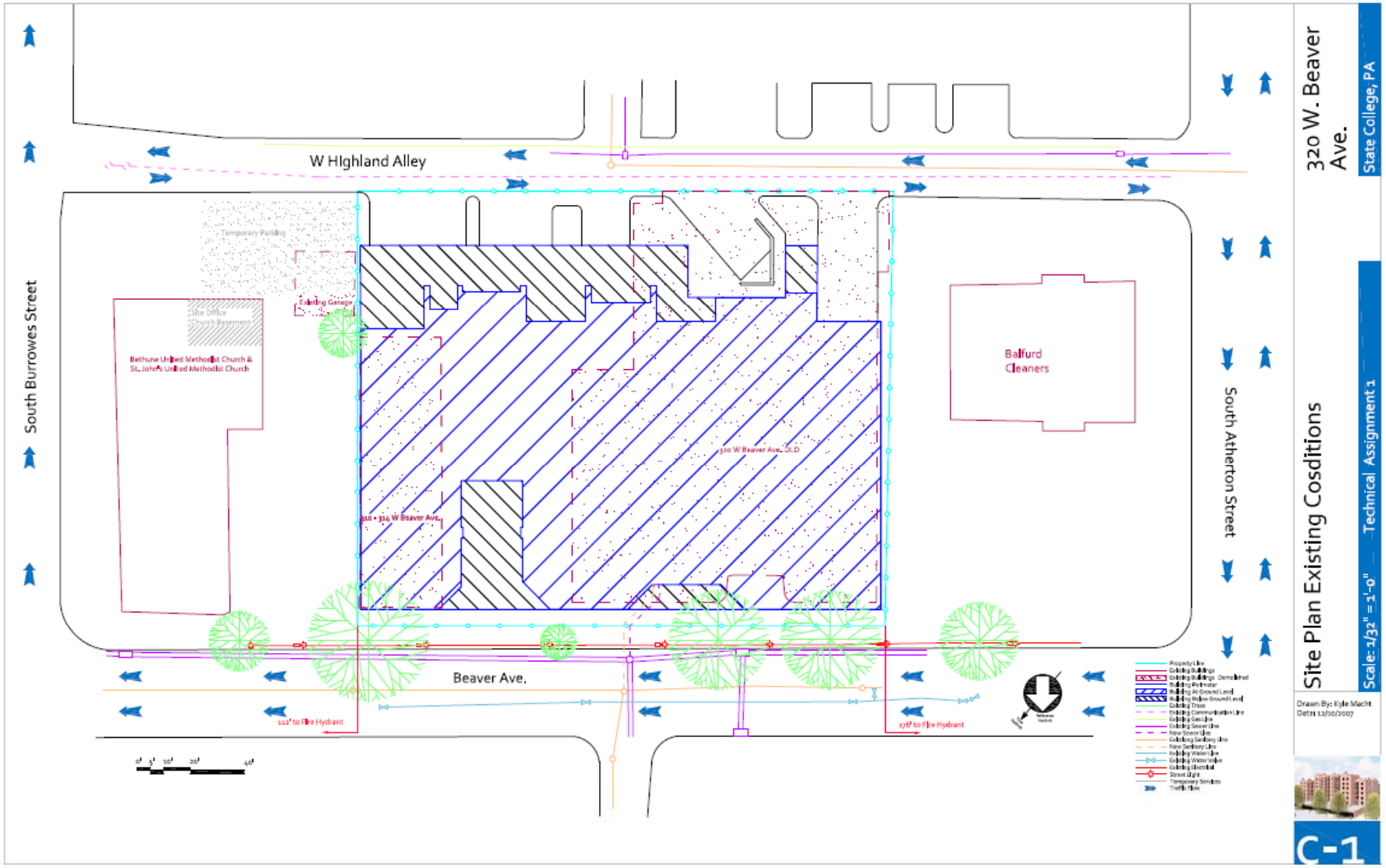
- **Project Overview**
  - Cost: $15,000,000
  - Size: 133,000 SF
  - Floors
    - -2 through 0 — Below grade parking garage
    - 1 — Commercial space on the north side and parking in the rear
    - 2 through 7 — Student Apartments
      - 10 one bedroom apartments
      - 55 two bedroom apartments



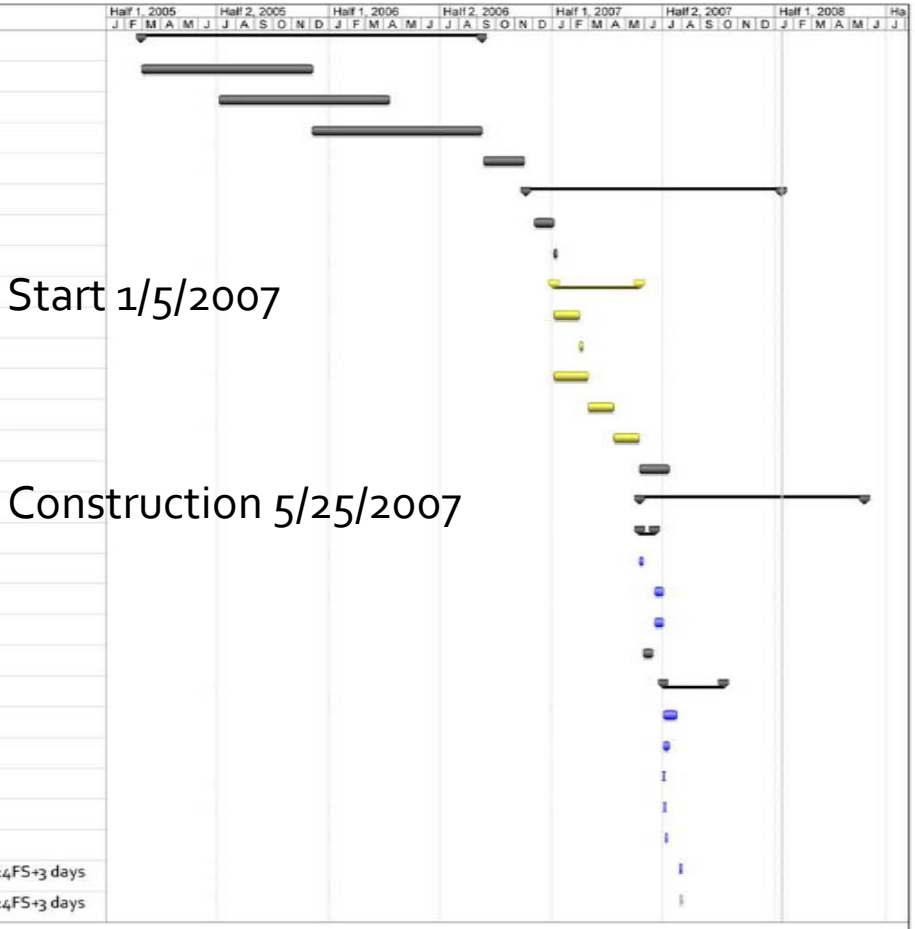
The Palmerton

Downtown State College, Pa




W HIghland Alley
South Burrowes Street
South Atherton Street
Beaver Ave.
Temporary Parking
Existing Garage
Site Office
Church Basement
Bethune United Methodist Church &
St. John's United Methodist Church
Balfurd
Cleaners
320 W Beaver Ave. OLD
320 - 324 W Beaver Ave.
112' to Fire Hydrant
176' to Fire Hydrant
320 W. Beaver Ave.
State College, PA
Site Plan Existing Cosditions
Technical Assignment 1
Scale: 1/32" = 1'-0"
Drawn By: Kyle Macht
Date: 12/10/2007
C-1

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Design Phase**	400 days	Mon 2/28/05	Fri 9/8/06	
2	Schematic Design	200 days	Tue 3/1/05	Mon 12/5/05	
3	Design Development	200 days	Tue 7/5/05	Mon 4/10/06	
4	Construction Documents	200 days	Mon 12/5/05	Fri 9/8/06	
5	**Bidding**	50 days	Mon 9/11/06	Fri 11/17/06	4
6	**Procurement of construction services**	300 days	Mon 11/20/06	Fri 1/11/08	5
7	**Demolition**	24 days	Mon 12/4/06	Thu 1/4/07	5FS+10 days
8	Temporary Electrical Connection	3 days	Fri 1/5/07	Tue 1/9/07	7
9	Excavation	100 days	Fri 1/5/07	Thu 5/24/07	7
10	Shoring Pipes	30 days	Fri 1/5/07	Thu 2/15/07	7
11	Pour Shoring Pipes	3 days	Fri 2/16/07	Tue 2/20/07	10
12	Drill Pre-Split holes	40 days	Fri 1/5/07	Thu 3/1/07	7
13	Blasting	30 days	Fri 3/2/07	Thu 4/12/07	12
14	Soil and Rock Removal	30 days	Fri 4/13/07	Thu 5/24/07	13
15	**Contaminated Soil Removal**	35 days	Fri 5/25/07	Thu 7/12/07	9
16	**Construction Phase**	262 days	Fri 5/25/07	Mon 5/26/08	9
17	**Foundations**	17 days	Fri 5/25/07	Mon 6/18/07	9
18	Elevator Slab	4 days	Fri 5/25/07	Wed 5/30/07	9
19	Exterior Footers	10 days	Tue 6/19/07	Mon 7/2/07	9,17
20	Interior Footers	10 days	Tue 6/19/07	Mon 7/2/07	9,17
21	Crane Setup	12 days	Thu 5/31/07	Fri 6/15/07	18
22	**Parking Garage Structure**	70 days	Tue 7/3/07	Mon 10/8/07	19, 21
23	Exterior Wall	16 days	Tue 7/3/07	Tue 7/24/07	19, 21
24	Colums and Interior Walls 1st Level	8 days	Tue 7/3/07	Thu 7/12/07	20,21
25	Lay Stone for Basement Slab	1 day	Tue 7/3/07	Tue 7/3/07	19, 20
26	Install Vapor Barrier	2 days	Wed 7/4/07	Thu 7/5/07	25
27	Instal WWF for Basement Slab	2 days	Fri 7/6/07	Mon 7/9/07	26
28	Beams First Level	3 days	Mon 7/30/07	Wed 8/1/07	23FS+3 days, 24FS+3 days
29	Ground Floor CMU Walls	5 days	Mon 7/30/07	Fri 8/3/07	23FS+3 days, 24FS+3 days

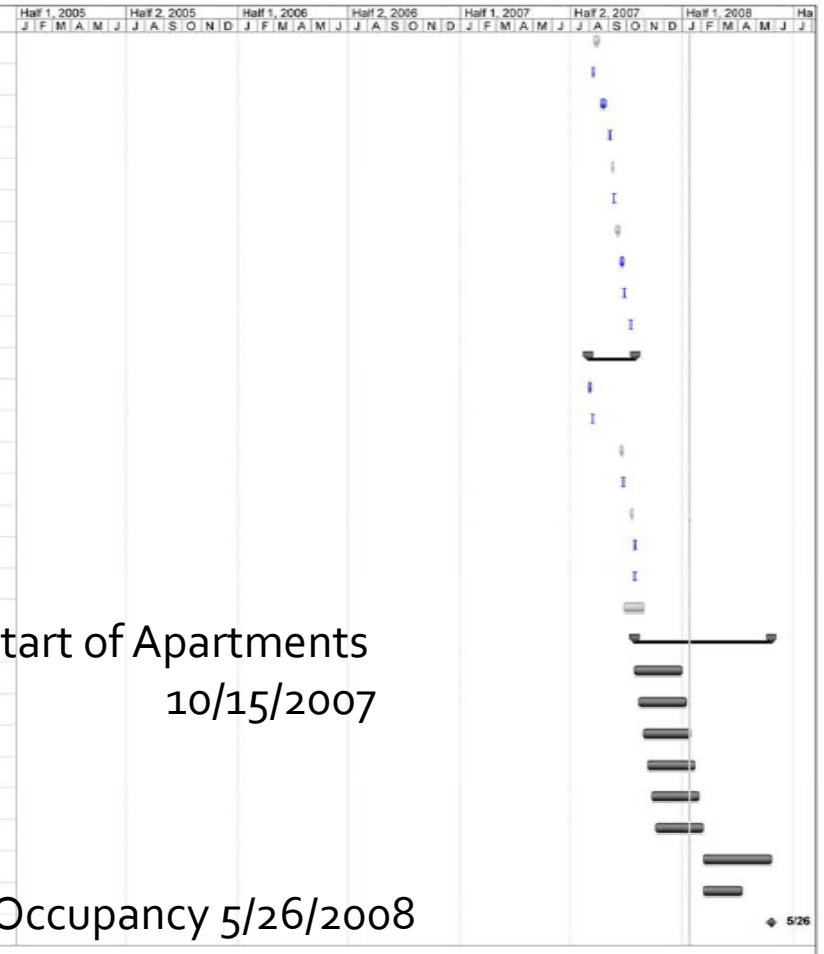


Project: 320 Beaver Ave 2
Date: Sat 1/12/08

Task | Smaller Summary | Overview Summary | Milestone

General Contractor : Poole Anderson Construction | Site Work : Glen O. Hawbaker | Concrete : Lorme G. Seifert | Masonry Work & Plank Setting : Harris Masonry

ID	Task Name	Duration	Start	Finish	Predecessors
30	Precast Floor 2nd level	7 days	Thu 8/9/07	Fri 8/17/07	28FS+5 days
31	Basement Slab	4 days	Mon 8/6/07	Thu 8/9/07	27,29
32	Cast in Place Walls 2nd level	7 days	Mon 8/20/07	Tue 8/28/07	30
33	Ground level Beams	2 days	Mon 9/3/07	Tue 9/4/07	32FS+3 days
34	Place 2nd level CMU	2 days	Fri 9/7/07	Mon 9/10/07	32FS+7 days
35	Pour Topping Slab 2nd level	1 day	Tue 9/11/07	Tue 9/11/07	34
36	Precast Floor Ground Level Parking	5 days	Fri 9/14/07	Thu 9/20/07	33FS+7 days
37	Ground Level Parking Walls and Columns	4 days	Fri 9/21/07	Wed 9/26/07	36
38	Beams 2nd Floor Above Parking	2 days	Thu 9/27/07	Fri 9/28/07	37
39	Pour Topping Ground Floor Parking	1 day	Mon 10/8/07	Mon 10/8/07	37FS+7 days
40	**Commercial Space Structure**	55 days	Tue 7/31/07	Mon 10/15/07	23FS+4 days
41	Commercial Footers	4 days	Tue 7/31/07	Fri 8/3/07	23FS+4 days
42	Ground Floor Slab on Grade	2 days	Mon 8/6/07	Tue 8/7/07	41
43	Precast Floor Ground Level Commercial	3 days	Fri 9/21/07	Tue 9/25/07	36
44	Ground Level Walls and Columns	1 day	Wed 9/26/07	Wed 9/26/07	43
45	Ground Floor CMU	5 days	Mon 10/8/07	Fri 10/12/07	44FS+7 days
46	Beams 2nd Floor	2 days	Mon 10/15/07	Tue 10/16/07	45
47	Pour Topping Ground Level	1 day	Mon 10/15/07	Mon 10/15/07	45
48	Brick first floor only	24 days	Thu 9/27/07	Tue 10/30/07	44
49	**Apartments**	161 days	Mon 10/15/07	Mon 5/26/08	38,45
50	**Floor 2**	56 days	Mon 10/15/07	Mon 12/31/07	38,45
51	**Floor 3**	56 days	Mon 10/22/07	Mon 1/7/08	50FS-51 days
52	**Floor 4**	56 days	Mon 10/29/07	Mon 1/14/08	51FS-51 days
53	**Floor 5**	56 days	Mon 11/5/07	Mon 1/21/08	52FS-51 days
54	**Floor 6**	56 days	Mon 11/12/07	Mon 1/28/08	53FS-51 days
55	**Floor 7**	56 days	Mon 11/19/07	Mon 2/4/08	54FS-51 days
56	Finishes	80 days	Tue 2/5/08	Mon 5/26/08	55
57	Landscape	46 days	Tue 2/5/08	Tue 4/8/08	55
58	Occupancy	0 days	Mon 5/26/08	Mon 5/26/08	57,56



Start of Apartments
10/15/2007

Occupancy 5/26/2008

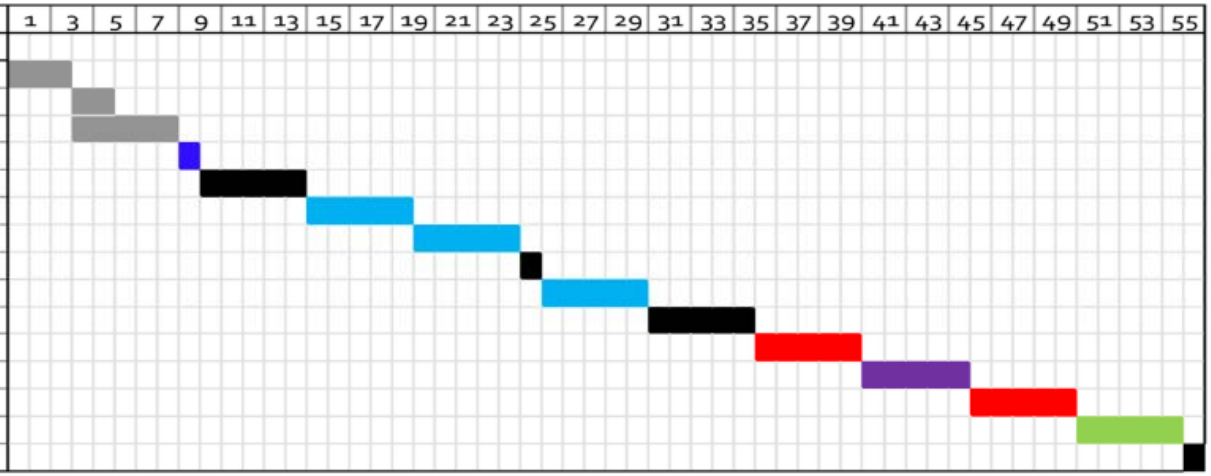
Project: 320 Beaver Ave 2
Date: Sat 1/12/08

Task | Smaller Summary | Overview Summary | Milestone

General Contractor: Poole Anderson Construction | Site Work: Glen O. Hawbaker | Concrete: Lorne G. Seifert | Masonry Work & Plank Setting: Harris Masonry

Short Interval Production Schedule for a typical floor

	Sips Schedule, Typical Floor		Days
	Task Name	Duration	Predecessor
1	Hollow Core Planks	3 days	
2	Plank Connections	2 days	1
3	CMU Walls	5 days	1
4	Pour Topping Slab	1 day	2,3
5	Exterior Walls	5 days	4
6	Exterior Sheathing	5 days	5
7	Water Proofing	5 days	6
8	Windows	1 day	7
9	EIFS	5 days	8
10	Interior Framing	5 days	5
11	Mechanical Rough-In	5 days	10
12	Plumbing Rough-In	5 days	11
13	Electrical Rough-In	5 days	13
14	Drywall	5 days	13
15	Paint	1 day	15



Legend	
Harris Masonry	
Lorne G. Seifert	
Poole Anderson Construction	
Macron Roofing	
Allied Mechanical and Electrical	
R&R Plaster	

Research: *Sustainable Student Apartment Buildings*

- **Goal**
  - Show that there is a demand for sustainable apartment buildings
- **Approach**
  - Create a survey
  - Test the survey
  - Implement the survey
  - Analyze the results

Survey

- Format the survey based on LEED principles
  - Site
  - Water
  - Energy and atmosphere
  - Materials & Resources
  - Energy & Atmosphere

Architectural Engineering - Senior Thesis Research Survey — Kyle Macht

Please either circle or fill in the blank, for your most correct answer.

Age: _____ Male or Female

Major: _____

Do you live in a student apartment building or a dorm? Y N

Do you personally pay your own rent? Y N
If so, how much do you pay per month? $ _____

Do you pay your own electric and heating bill? Y N
If so, how much do you pay on average per month? $ _____

1 Do you have a green outdoor space nearby your current apt. building? Y N
2 How much would you be willing to pay a month to have a usable, exterior green space? $ _____

1 Do you care where your energy is currently coming from? Y N
2 How much would you be willing to pay a month to have environmentally friendly energy, such as solar and wind? $ _____

1 Do you feel that you have enough daylight in your current apt. such that you don't need to turn on the lights during the day? Y N
2 How much would you be willing to pay a month for sufficient daylight in your apartment such that you wouldn't need other lighting during the day? $ _____

1 Do you care about the environmental impacts of the materials in your apt.? For instance, was the wood sustainably havested or from an old growth forest. Were your materials made from recyled content. Y N
2 How much would you pay to minimize the overall environmental impacts, with respect to materials? $ _____

1 Are you concerned about the contents of the air you breath in your current apt.? For example, the air having high CO_2 levels, mold, potential harmfull chemicals that can get trapped in fabrics and carpet. Y N
2 How much would you be willing to pay for cleaner air ? $ _____

1 Did you answer 4 out of the 5 questions labeled #2, with a number greater than 0? Y N
a If no, would you want to live in a green building if it cost the same? Y N

b If yes, you want to live in a green student apartment building! This type of building is healthier for you and the environment, adn uses less energy the typical building. You said that you would be willing to pay more for this building, however you do not have too! When designed correctly, green buildings can potentially cost less.

Thank You!

Analysis

- 99 students took the survey
  - The sample was mostly taken from students in the HUB
  - The rest of the sample was taken in an Industrial Engineer's class
- The results were split into 3 areas
  - Students who pay their own rent, 48%
  - Students who do not pay their own rent, 42%
  - Students that had unreasonably high answers, 10%

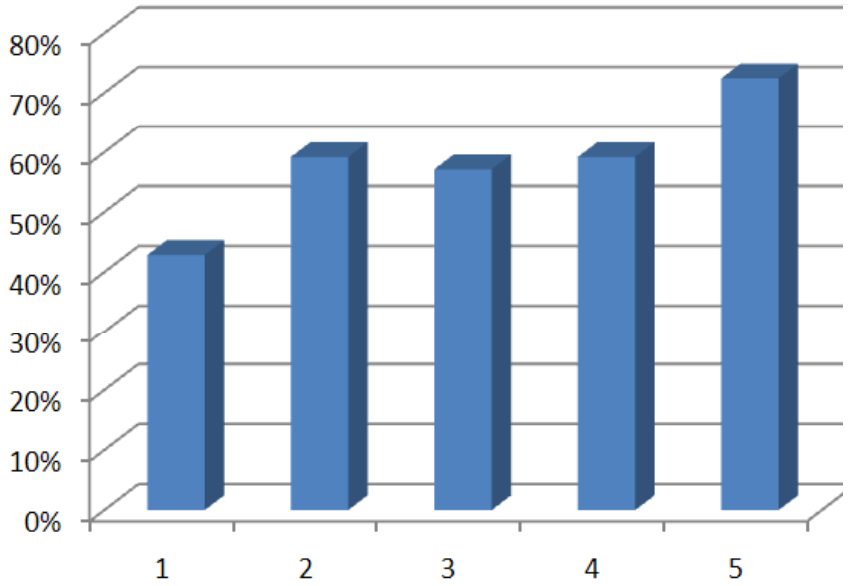
Results

- 99% of students would prefer to live in a green student apartment building
- 85% of students would pay a marginal amount more to live in a green student apartment building
- 41% of students would pay more in 4 or more different areas

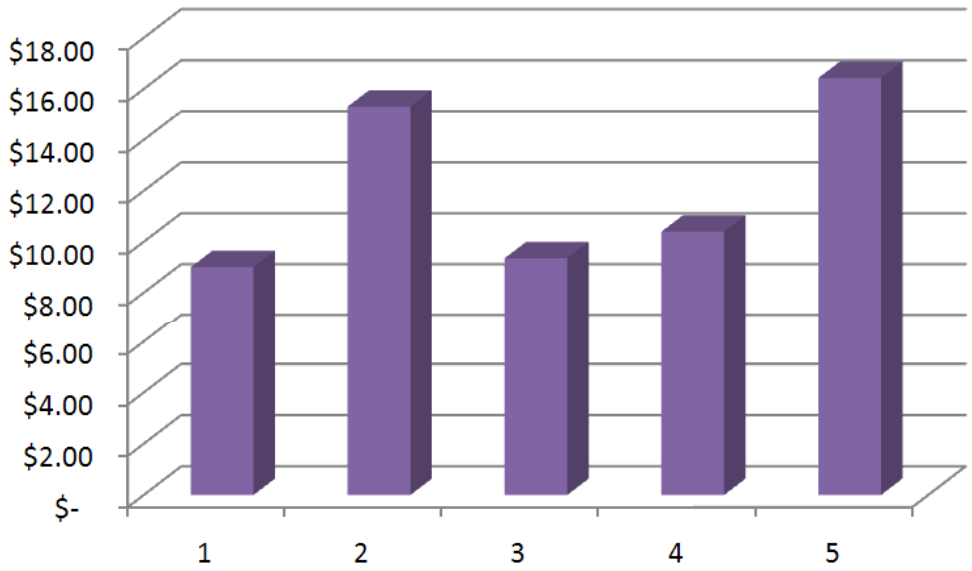
- There were slight differences between those who pay rent and those who do not
  - Students who pay their own rent were willing to pay $67.85 per month where students who do not pay their own rent would pay $52.06
  - The main difference between the two, was paying for cleaner energy

Survey

How many would pay more per scenario



On average how much students would pay extra for each scenario

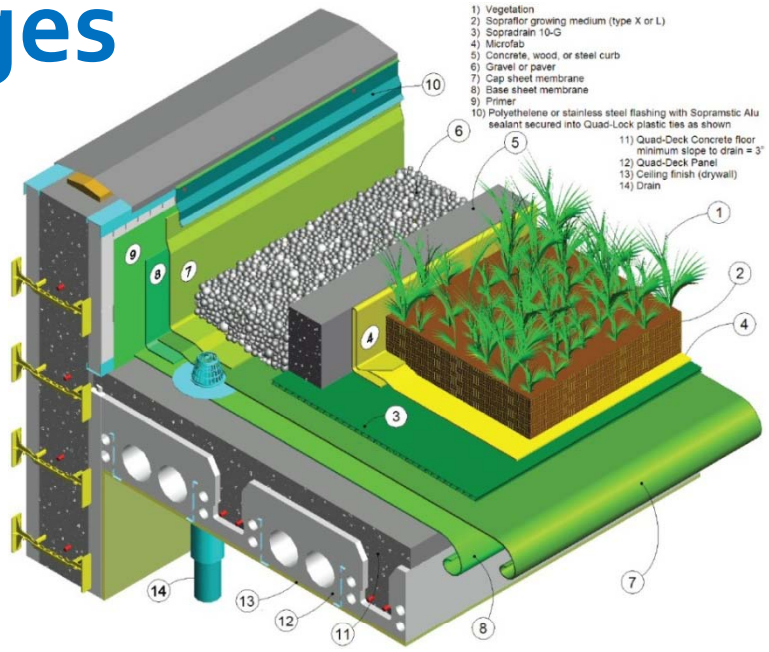


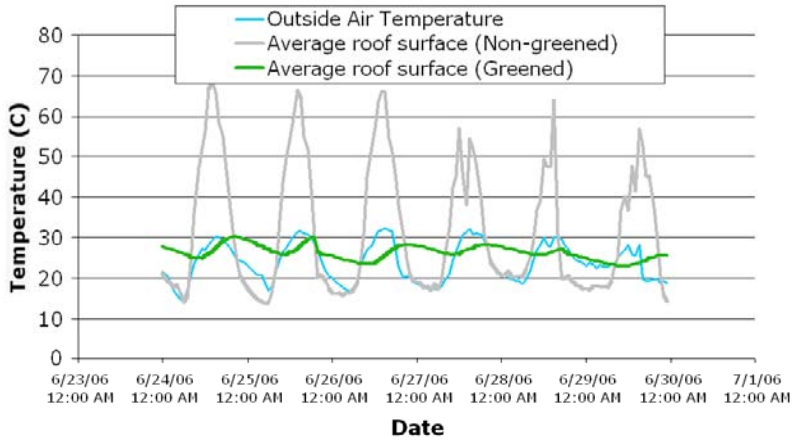
Analysis 2: Green Roof

- ***Problem Statement***
  - Above the commercial space in the Palmerton, is a large standard flat roof with three air handling units on it. This roof has a high amount of visibility. This roof has the potential to be something more. It could be one of the defining characteristic of the building.
- ***Goal***
  - Implement an intensive green roof .
- **Approach**
  - First, add value to the building
  - Second, analyze the existing structure and redesign it when necessary, **Breadth 1**
  - Third, design the layout and the access to the roof

Green Roof Advantages

- Helps reduce the need for storm water management
  - Retains water, while filtering and cleaning it
- Green roofs can last 2 to 3 times as long as typical roofs
- Added insulation
  - Photosynthesis helps keep roof cool during the daytime
  - Helps reduce heat island effect

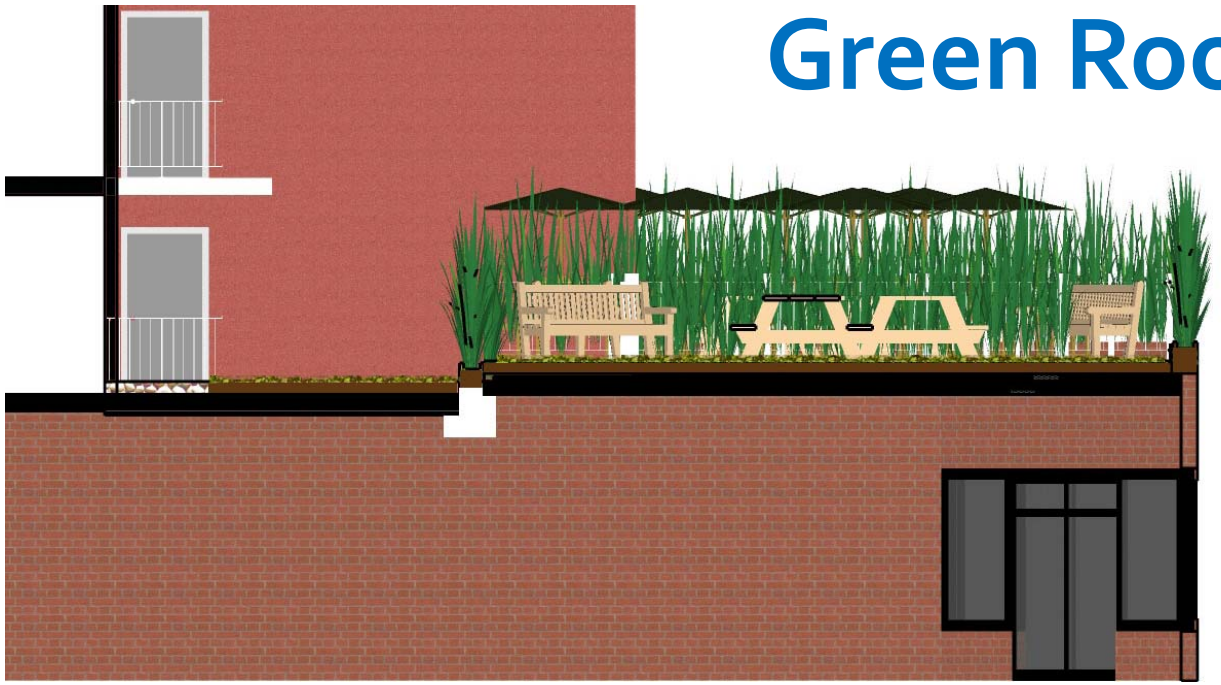




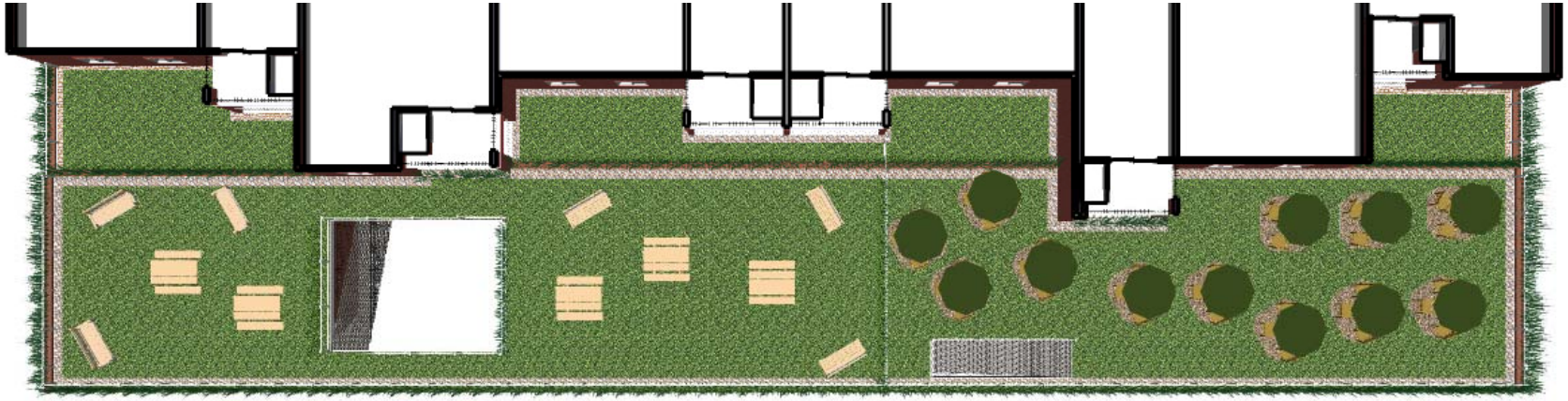
Green Roof Design

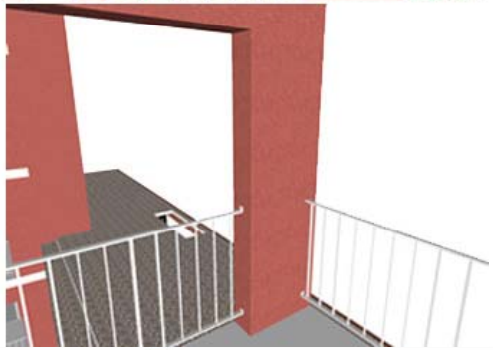
- To achieve privacy with low weight, it made sense to have a 4" green roof with planter boxes directly above the beams below
- This allowed the weight to stay lower, letting the design keep hollow core planks
- Two stairwells were added
  - One for the residents
  - One for the commercial space
  - For simplicity these became outdoor stair wells

Green Roof Design



- Big Bluestem
- Little Bluestem
- Ostrich Fern
- Coral Carpet





	Rate Per Month
1	$ 20.00
2	$ 75.00
3	$ -
4	$ 15.00
5	$ 50.00
6	$ 50.00
7	$ 25.00
8	$ 50.00
9	$ 50.00
10	$ 50.00
11	$ 20.00
12	$ 20.00
13	$ 20.00
14	$ 100.00
15	$ 110.00
16	$ 25.00
17	$ 50.00
18	$ 100.00
19	$ 75.00
20	$ 100.00
21	$ 50.00
22	$ 50.00
23	$ 10.00
24	$ -
25	$ 20.00
26	$ 50.00
27	$ 25.00
28	$ 50.00
29	$ 10.00
30	$ 50.00
31	$ 30.00
32	$ 25.00
33	$ 50.00
34	$ 50.00
Avg.	$ 43.38
Mean	$ 50.00
Min	$ -
Max	$ 110.00

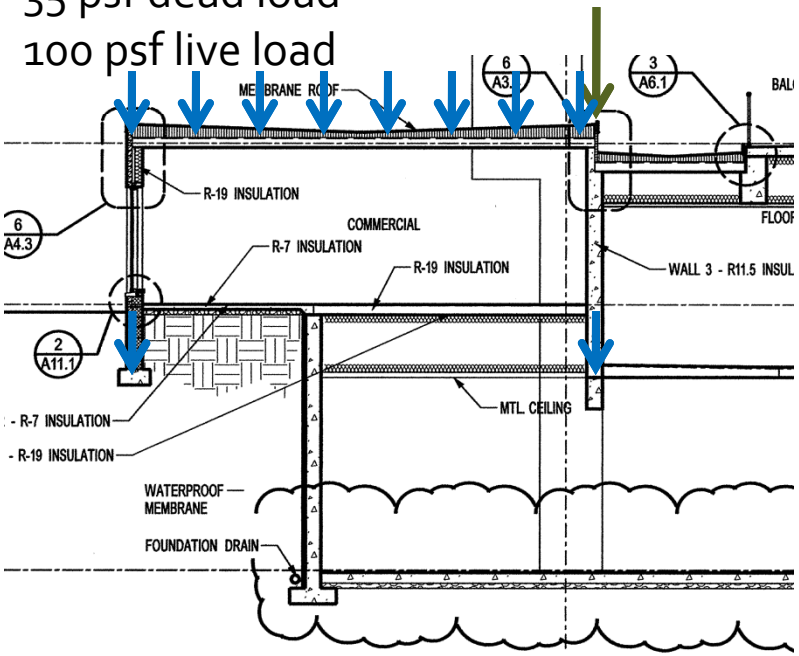
Green Roof Survey

- How much more would you as a Penn State student be willing to pay to have this green roof implemented on your building
- The most common response was $50 a month, with the lowest being $0 a month and the highest at $110 a month
- Assuming the owner charges $40, this green roof will make $9,600 a month, that's $115,200 a year from the residents alone

Structural Redesign

- Typically designed to be an 8 story building
  - The additional weight of the non existent 8th story allowed the columns to remain unchanged
- An increase in Dead load to 35psf
  - From Tecta Green Roof
- An increase in Live load from 20psf to 100psf
- This resulted in an increase in plank depth from 8" to 10"
- The beams supporting the planks need to be increased
  - the beams on the building side need to be increased
- On the north side the beams and columns need to be sized larger to handle the additional weight
- The footers will also need to be increased on the north side

30 psf snow load
35 psf dead load
100 psf live load



- The north beams have to resist a moment of 338 kft, so an HSS 14x10x5/8 was chosen which can resist 414 kft
- The footers need to withstand 130k so a footer was designed to hold 150k

- Using Ws Long's numbers, the precast concrete manufacturer for the job, this will require a 10" hollow core plank being able to support 197 psf
- Using this the load on the south beams comes to 7.1 klf
  - From the PCI handbook a 32" deep inverted T beam can support this, which was the same depth as the existing cast in place beam
- Additional weight from the designed 8th floor, 47.67k, the proposed weight on the columns are 47.62k, therefore the columns can support the new green roof
- The columns on the north side also needed to be increased to hold 127 k, so a HSS 10x5x1/4 was chosen which can hold 157 k

Cost Analysis

- Commercial pays
  - $5,000 to $10,000 a month
- Residents pay
  - $9,600 per month
- Equates to a 9 month payback
- With the lowest numbers
  - Commercial pays $5,00 a month, residents pay nothing
  - Payback of 3 years

Item	Size	Type	Unit	Mat	Lab	total	#	Total
Table 5: Green Roof Comparison								
Existing								
Spread Footer	8"	3000 PSI	SF	$ 241.00	$ 297.00	$ 538.00	8	$ 4,304.00
Steel Column	8x8	HSS8x8	EA	$ 555.00	$ 43.50	$ 598.50	8	$ 4,788.00
Steel Beam	12x8	HSS12x8x5/8	LF	$ 37.30	$ 13.80	$ 51.10	190	$ 9,709.00
	12x35	W12x35	LF	$ 36.39	$ 2.66	$ 39.05	24	$ 937.20
Concrete Beam	32	Cast in Place	CY	$ 298.00	$ 385.00	$ 683.00	27	$ 18,441.00
Screens for AHU	60"	Ruskin Screen	LF	$ 20.00	$ 20.00	$ 40.00	68	$ 2,720.00
Hollow Core	8"	15 strand	SF	$ 8.15	$ 4.61	$ 12.76	6487	$ 82,774.12
Roof		4 plies & gravel	SF	$ 1.49	$ 1.62	$ 3.11	6487	$ 20,174.57
Total								$ 143,847.89
Proposed With Green Roof								
Spread Footer	8"	3000 PSI	LF	$ 460.00	$ 500.00	$ 960.00	8	$ 7,680.00
Steel Column	10x5	HSS10x5x3/8	EA	$ 555.00	$ 43.50	$ 598.50	8	$ 4,788.00
Steel Beam	14x10	HSS14x10x5/8	LF	$ 45.62	$ 14.80	$ 60.42	190	$ 11,479.61
	12x72	W12x72	LF	$ 75.00	$ 3.40	$ 78.40	24	$ 1,881.60
Concrete Beam	24'	Precast T 12x32	EA	$ 193.00	$ 12.88	$ 205.88	9	$ 1,852.92
Planter Box	1'	Brick with 2x4	SF	$ 6.65	$ 12.65	$ 19.30	840	$ 16,212.00
		Soil and Plants		$ 25.00	$ 1.51	$ 26.51	840	$ 22,268.40
Railing	4'	Simple Metal	LF	$ 11.30	$ 6.10	$ 17.40	280	$ 4,872.00
Hollow Core	10"	15 strand	SF	$ 8.80	$ 4.28	$ 13.08	6287	$ 82,233.96
Stairs	10'	Metal 16 Risers	EA	$ 7,775.00	$ 1,825.00	$ 9,600.00	2	$ 19,200.00
Roof		4 plies	SF	$ 1.02	$ 1.70	$ 2.72	6287	$ 17,100.64
Green Roof	4"		SF	$ 20.00	$ 1.51	$ 21.51	6287	$ 135,233.37
Total								$ 324,802.50

Schedule

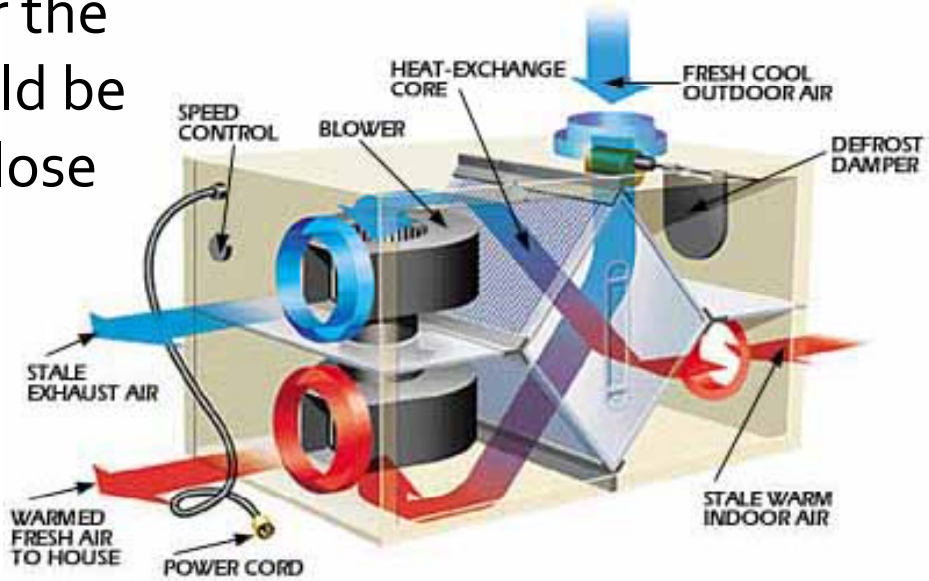
- The green roof will add about 4 weeks to the schedule that can be done while finishes are happening, therefore there is no interference in construction
- To get the materials to the roof, either the workers can carry items up the stairs or a telescoping fork lift can be used
- Due to the use of precast beams the time for structural construction drops from onsite work of 220hours to 18hours
  - This will help make up for any time lost due to the larger size of members

Analysis 3: Mechanical Redesign

- ***Problem Statement***
  - The present mechanical system is scattered throughout the building
  - There is also no chance for energy recovery
- ***Goal***
  - Run a water loop around the building for the heat pumps to exchange heat with
  - Install an energy recovery ventilator in each apartment
- **Approach**
  - First, analyze the existing system
  - Second, design the new mechanical system, **Breadth 2**
  - Third, perform a constructability review and cost analysis

Energy Recovery Ventilator

- An energy recovery ventilator (ERV) allows up to 75% heat transfer between the outside fresh air and the stale indoor air
  - This allows for the larger heat pump for the 2 bedroom to be downsized from a 2.5 ton to a 2 ton heat pump
  - The smaller heat pump for the 1 bedroom apartment could be downsized, but it was to close to confidently downsize



Energy Recovery Ventilator

- The ERV will be installed in the mechanical closet
- The ERV can eliminate the need for exhaust fans
- The ERV can condense the ductwork to one run

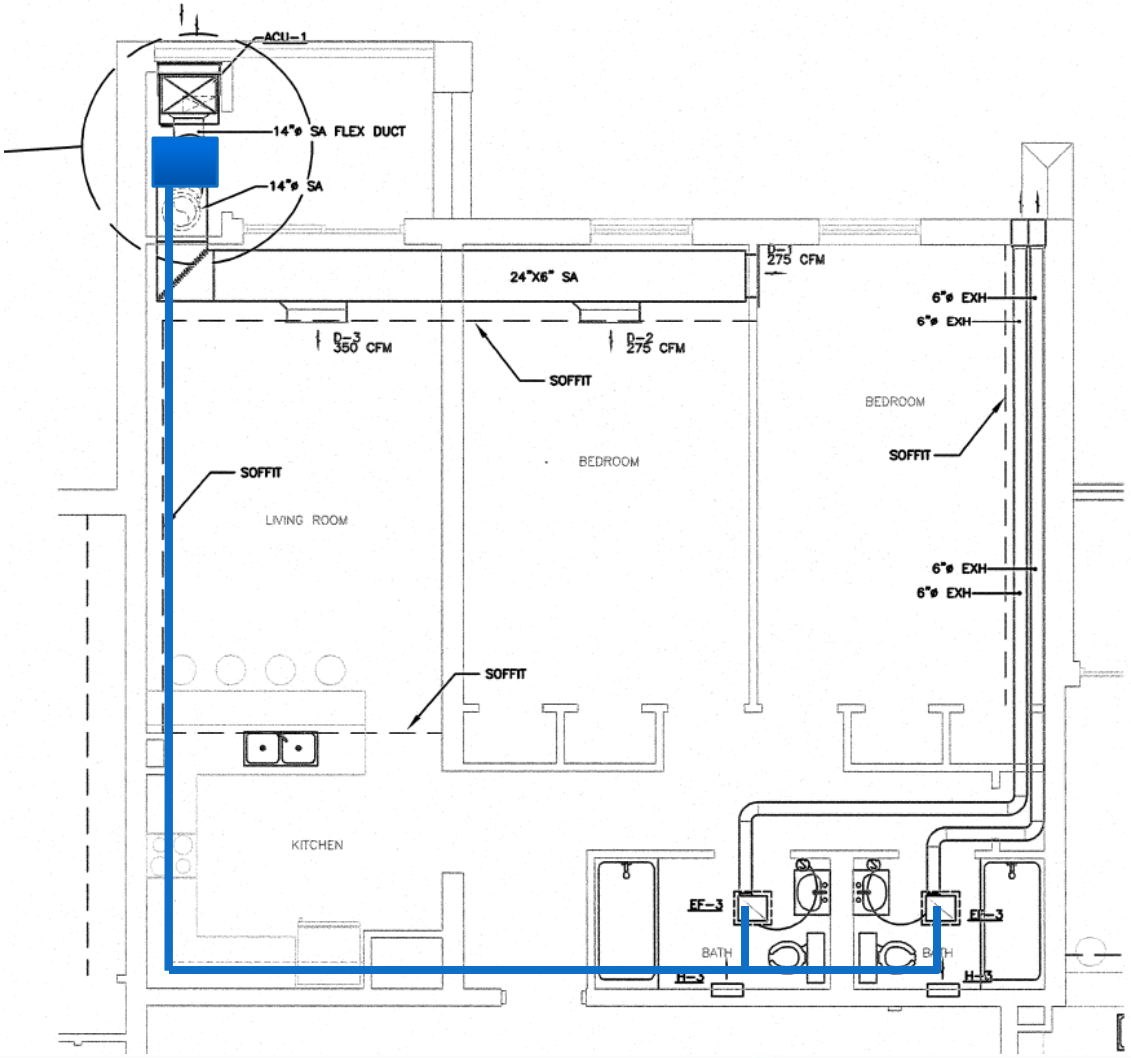


Table 8: Mechanical Redesign ERV Estimate														
Item	Size	Type	Unit	Labor Hours	Materials	Labor	Total	Tot. 2 BR	Total	Time	Tot. 1 BR	Total	Time
Existing													
Spiral	6"	straight	LF	0.057	$ 1.76	$ 2.17	$ 3.93	72	$ 280.00	4	30	$ 117.90	1.71
Ductwork	6"	connector	Ea	0.182	$ 2.60	$ 6.90	$ 9.50	4	$ 38.00	1	2	$ 19.00	0.36
	6"	elbow	Ea	0.364	$ 5.75	$ 13.80	$ 19.55	4	$ 78.20	1	2	$ 39.10	0.73
Brick Vent	6"		Ea	0.333	$ 25.00	$ 14.05	$ 39.05	2	$ 78.10	1	1	$ 39.05	0.33
Exhaust fan	130	Nutone QT140L	Ea	0.83	$ 200.00	$ 32.50	$ 232.50	2	$ 465.00	2	1	$ 232.50	0.83
Heat Pump	2.5	Air Source	Ea	13.333	$ 1,625.00	$ 515.00	$ 2,140.00	1	$ 2,140.00	13	0	$ -	0.00
Heat Pump	1.5	Air Source	Ea	13.115	$ 1,575.00	$ 510.00	$ 2,085.00	0	$ -	0	1	$ 2,085.00	13.12
Total									**$ 3,079.30**	**22**		**$ 2,532.55**	**17.08**
Total All Apts.									**$ 169,361.50**	**1207**		**$ 25,325.50**	**171**
Proposed With ERV													
Spiral	6"	straight	LF	0.057	$ 1.76	$ 2.17	$ 3.93	66	$ 260.00	4	42	$ 165.06	2.39
Ductwork	6"	connector	Ea	0.182	$ 2.60	$ 6.90	$ 9.50	5	$ 47.50	1	4	$ 38.00	0.73
	6"	elbow	Ea	0.364	$ 5.75	$ 13.80	$ 19.55	2	$ 39.10	1	3	$ 58.65	1.09
	6"	tee	Ea	0.533	$ 8.20	$ 20.00	$ 28.20	1	$ 28.20	1	0	$ -	0.00
Flex Ductwork	8"	non-insulated	LF	0.08	$ 2.20	$ 3.03	$ 5.23	24	$ 125.52	2	8	$ 41.84	0.64
Can Light		recessed	Ea	0.4	$ 77.50	$ 16.80	$ 94.30	2	$ 188.60	1	1	$ 94.30	0.40
Heat Pump	2	Water Source	Ea	9.412	$ 1,300.00	$ 365.00	$ 1,665.00	1	$ 1,665.00	9	0	$ -	0.00
Heat Pump	1.5	Water Source	Ea	10	$ 1,375.00	$ 390.00	$ 1,765.00	0	$ -	0	1	$ 1,765.00	10.00
ERV		Renewair 70	Ea	5	$ 675.40	$ 500.00	$ 1,175.40	1	$ 1,175.40	5	1	$ 1,175.40	5.00
Total									**$ 3,529.32**	**23**		**$ 3,338.25**	**20.25**
Total All Apts.									**$ 194,112.60**	**1269**		**$ 33,382.50**	**203**

ERV Payback

Totals:	Existing	Proposed
	$194,700	$227,500

The energy recovery ventilator will save approximately $200 a year per apartment.

(*Sound Geothermal Inc.*)

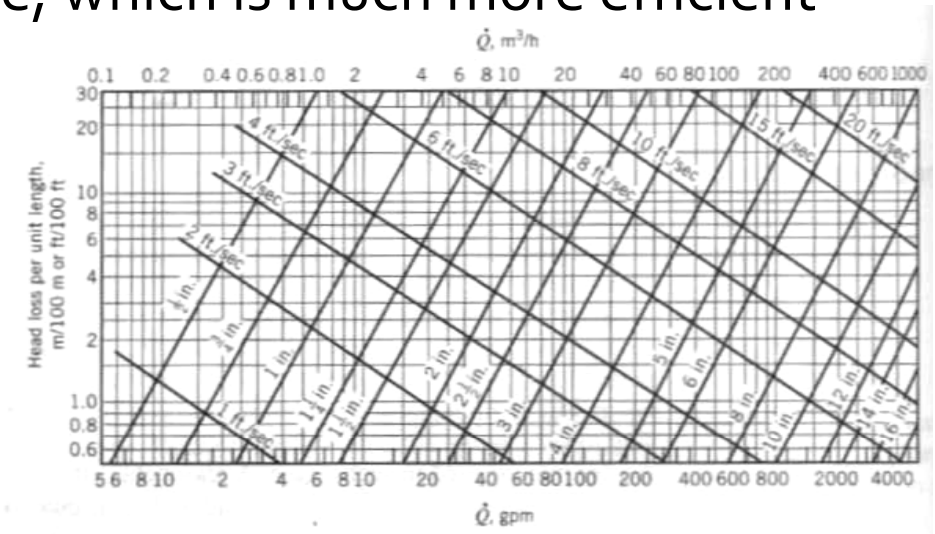
This equates to a 2.4 year payback period and will continue to save $13,000 a year

Water Loop

- Running 60 degree F to 90 degree F water throughout the building and maintaining the temperature with a condenser and a boiler, allows the smaller heat pumps to exchange heat with them and will eliminate peak loads
- This will also allow the heat pumps to exchange with water instead of air on the one side, which is much more efficient

Table 6: Pipe Work Calculations

1 BR Shaft			2 Bedroom Shaft		
Story	Flow Rate	Size	Story	Flow Rate	Size
			7	38.5	1.5
6	25.2	1.5	6	33	1.5
5	21	1.25	5	27.5	1.5
4	16.8	1.25	4	22	1.25
3	12.6	1	3	16.5	1.25
2	8.4	1	2	11	1
1	4.2	0.75	1	5.5	0.75



Water Loop

Implementing the water loop will increase the efficiency of the system about 8% - 12%

Table 9: Mechanical Redesign Water Loop Estimate													
Proposed Water Loop													
Piping	0.75	Schedule 40	LF	0.131	$	2.40	$	5.60	$	8.00	212	$ 260.00	28
	1	Schedule 40	LF	0.151	$	3.47	$	6.45	$	9.92	288	$ 2,856.96	43
	1.25	Schedule 40	LF	0.18	$	4.56	$	6.90	$	11.46	288	$ 3,300.48	52
	1.5	Schedule 40	LF	0.2	$	5.35	$	7.70	$	13.05	1254	$ 16,364.70	251
	2	Schedule 40	LF	0.25	$	7.10	$	9.60	$	16.70	248	$ 4,141.60	62
	2.5	Schedule 40	LF	0.32	$	11.00	$	12.30	$	23.30	100	$ 2,330.00	32
	4	Water Source	LF	0.444	$	21.00	$	17.10	$	38.10	80	$ 3,048.00	36
Pump	600		Ea	14.118	$	3,150.00	$	340.00	$	3,490.00	1	$ 3,490.00	14
Boiler	1275	MBH	Ea	80	$	10,300.00	$	3,275.00	$	13,575.00	1	$ 13,575.00	80
Cooling Tower	167	Tons	Ea	32	$	25,900.00	$	1,275.00	$	27,175.00	1	$ 27,175.00	32
Total												**$ 76,541.74**	**630**

- Considering the additional cost of $76,600, this system will take 12.3 to 18.5 years to pay back
- If some downsizing of the small heat pump this could reduce these numbers slightly
- An energy model and analysis would have to be performed

Proposed Schedule

Appendix A: Green Roof and Mechanical Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
31	Basement Slab	4 days	Mon 8/6/07	Thu 8/9/07	27,29
32	Cast in Place Walls 2nd level	7 days	Mon 8/20/07	Tue 8/28/07	30
33	Ground level Beams	2 days	Mon 9/3/07	Tue 9/4/07	32FS+3 days
34	Place 2nd level CMU	2 days	Fri 9/7/07	Mon 9/10/07	32FS+7 days
35	Pour Topping Slab 2nd level	1 day	Tue 9/11/07	Tue 9/11/07	34
36	Precast Floor Ground Level Parking	5 days	Fri 9/14/07	Thu 9/20/07	33FS+7 days
37	Ground Level Parking Walls and Columns	4 days	Fri 9/21/07	Wed 9/26/07	36
38	Beams 2nd Floor Above Parking	2 days	Thu 9/27/07	Fri 9/28/07	37
39	Pour Topping Ground Floor Parking	1 day	Mon 10/8/07	Mon 10/8/07	37FS+7 days
40	Commercial Space Structure	55 days	Tue 7/31/07	Mon 10/15/07	23FS+4 days
41	Commercial Footers	4 days	Tue 7/31/07	Fri 8/3/07	23FS+4 days
42	Ground Floor Slab on Grade	2 days	Mon 8/6/07	Tue 8/7/07	41
43	Precast Floor Ground Level Commercial	3 days	Fri 9/21/07	Tue 9/25/07	36
44	Ground Level Walls and Columns	1 day	Wed 9/26/07	Wed 9/26/07	43
45	Ground Floor CMU	5 days	Mon 10/8/07	Fri 10/12/07	44FS+7 days
46	Beams 2nd Floor	0.25 days	Mon 10/15/07	Mon 10/15/07	45
47	Pour Topping Ground Level	1 day	Mon 10/15/07	Mon 10/15/07	45
48	[illegible]	24 days	Thu 9/27/07	Tue 10/30/07	44
49	Green Roof	25 days	Tue 10/16/07	Mon 11/19/07	40
50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
51	Floor 2	56 days	Mon 10/15/07	Mon 12/31/07	38,45
52	Floor 3	56 days	Mon 10/22/07	Mon 1/7/08	51FS-51 days
53	Floor 4	56 days	Mon 10/29/07	Mon 1/14/08	52FS-51 days
54	Floor 5	56 days	Mon 11/5/07	Mon 1/21/08	53FS-51 days
55	Floor 6	56 days	Mon 11/12/07	Mon 1/28/08	54FS-51 days
56	Floor 7	56 days	Mon 11/19/07	Mon 2/4/08	55FS-51 days
57	Water Loop	20 days	Tue 2/5/08	Mon 3/3/08	56
58	Finishes	80 days	Tue 3/4/08	Mon 6/23/08	57
59	Landscape	46 days	Tue 2/5/08	Tue 4/8/08	56
60	Occupancy	0 days	Mon 6/23/08	Mon 6/23/08	59,58

Qtr 1, 20 | Qtr 2, 20 | Qtr 3, 20 | Qtr 4, 20 | Qtr 1, 20 | Qtr 2, 20 | Qtr 3, 20 | Qtr 4, 20 | Qtr 1, 20 | Qtr 2, 20 | Qtr 3, 20 | Qtr 4, 20 | Qtr 1, 20 | Qtr 2, 20 | Qtr 3, 20

6/23

Project: The Palmerton
Date: Thu 4/10/08

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

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Conclusions

- In analysis 1, the survey clearly shows that there is a demand for sustainable student apartments
- The green roof will cost about $180,000.
  - Renting this space to a café or a restaurant would bring in $5,000 - $10,000 a month.
    - This alone makes the payback period 1.5 to 3.0 years.
  - Including the residents, it can cut the pay back time practically in half. Assuming residents will pay as much as they said they would the payback is in 9 months.
- An Energy Recovery Unit (ERV) will cost approximately $33,000 more per apartment, but will save about $200 a year per apartment. About $13,000 all together per year.
  - This will amount to a payback in 2.4 years.
- A water loop that runs throughout the building supplying 60°F to 90°F water to the heat pumps will cost an additional $76,500
  - This will pay back between 12.3 years to 18.5 years

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CM Advisor

Dr. Riley
Dr. Horman
CM Faculty

Mr. Parfitt
Mr. Holland
Thesis Advisors

Dr. Schneider
Dr. Bahnfleth
Seth Wilberding
Breadth Advisors

Tom Brasher
Poole Anderson

Michael Norris
Michael L. Norris & Associates, Inc.

Nic Jones
Sound Geothermal Inc.