TBD ENGINEERING | PROJECT DECISION MATRIX

			Pro	oject	Decis	sion	Matri	ix					
													Decision
	Notes/ Justification	1	2	3	4	5	6	7	8	9	10	Risks	X
Mechanical Systems													
FCU w/DOAS			4	3	4	1	4	5	3	3	4		
Valance Clg & Htg w/ DOAS		4	4	3	4	4	5	4	3	3	4		
WSHP w/ DOAS	Heat Rejection to Water Loop	4	4	3	4	5	3	4	3	3	5	Heat rejection to aquaponic system if present	X
Ground Source Heat Pump	Heat Rejection to Ground	4	3	3	4	5	3	3	2	3	4		
Electrical Distribution Options													
DC	renewable energy driven	2	4	3	3	5	3	5	2	3	5		
AC	standard from grid	4	5	3	3	3	3	5	3	3	3		Х
Generator Location Options													
Generator Outside		5	2	3	3	5	5	2	5	3	3	Invasive to site, prototypability affected	
Generator Basement		2	5	3	3	3	2	2	2	3	3		Х
Generator Roof		4	4	3	3	1	4	2	1	3	3	Invasive to growing spaces, fuel storage must be pumped vertically	
Grow Light Options			<u> </u>		<u> </u>	_			_			invasive to growing spaces, raci storage mast be pamped vertically	
LED	more specific wavelengths generated	5	Λ	3	5	5	2	Λ	Λ	ર	Λ		Y
HID		3	3	3	3	5	2	3	1	2	3	more power required, more maintenance	X
		J	3	3	J	J	J	<u> </u>		<u> </u>	<u> </u>	Iniore power required, more maintenance	
Support Space Lighting Options		Г	2	2	Г	1	2	Л	Г	ລ	А		V
LED		2	3	3	3	4	5	4	2	2	4	more newer required more resintances	X
FLUORESCENT		3	3	3	5	I	4	4	<u> </u>	<u> </u>	3	more power required, more maintenance	
Gravity System								_	_	_	_		
Steel Noncomposite		4	2	3	3	3	3	3	2	5	2		
Steel Composite		4	2	2	3	3	4	3	3	5	2		X
Steel Castellated Beams		4	3	3	3	4	5	3	5	4	4	Manufacturing different	
Timber Framing		2	2	5	3	4	2	1	2	2	4	Slightly specialized market	
Concrete Two2way slab		2	4	4	3	3	3	3	3	5	2		
Concrete pre-cast double tee		4	2	4	3	3	4	4	2	2	4	Slightly specialized market	
Concrete Post tension		3	3	2	3	3		4	1	2	2		
			<i>1</i>	5		J	3		2	1	<u>Z</u>		
Concrete Bubble deck		2	4	5	3	4	4	3 5	2	1	5	Extremely specialized market	
Acetylated wood		2	2	5	3	4	3	5	3	4	5		
Foundation System		4	2	2	2	2	2	4	2		2		
Mat Foundation		4	3	3	3	3	2	4	3	5	3		
Spread/Strip Footing		4	4	3	3	3	5	4	4	5	3		X
Beam (Grillage)		2	3	3	3	3	2	2	3	4	3	_	
Deep Foundations		2	2	3	3	3	2	3	2	2	4	Expensive, invasive, slow	
Slurry Wall		2	2	3	3	3	3	3	2	2	4	Expensive, invasive, slow	
Geopiers		4	4	4	3	4	5	4	4	2	5		X
Lateral Systems													
Steel Moment Frame	Requires Steel Gravity System	5	5	3	3	3	2	3	5	4	3		Х
Steel Braced Frame		2	4	3	3	3	3	3	3	4	3		
Masonry Shear Walls		2	2	4	3	3	3	4	1	4	3		
Concrete Moment Frame			5	4	3	3	4	4	4	4	3		
Concrete Shear Wall		2	3	4	3	3	4	4	2	4	3		
Green House Structural System		_											
Wood		2	2	Δ	3	Δ	5	1	2	5	4		
Steel		5	4	4	3	3	5	4	1	5	3		
Non-toxic Treated Wood		1	2	5	3	1	1	5	2	1	5		×
Façade Systems		4		3	3	4	4	<u> </u>	<u> </u>	-	<u> </u>		A
		2	1	2	2	1	1	Л	2	ာ	2		
Precast Panel		3		2	3	4	4	4	3	3		Efflorescence registure weight along	
Brick Cavity Wall		2	2		3	3	3	4	3	3		Efflorescence, moisture, weight, slow	V
Rain Screen		5	5	3	5	5	3	4	5	2	4	Terra Cotta shipping location	Х
Renewable Energy On Site								_					
Solar Power		3	5	5	5	4	5	3	2	_	3	Milwaukee building blocking some sunlight	
Wind Power		2	5	5	5	4	5	3	2	-	3	Invasive to Milwaukee site	
Anaerobic Digestion		2	4	3	3	5	4	2	3	3	4		X
Rainwater Collection	Effectiveness for GH and Rest of Building								1	1	1		

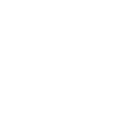
In order to consider a wide variety of options for the Growing Power facility, TBD developed and implemented a project decision matrix, shown left. Each design partner developed a list of options for various systems, listed in the leftmost column of the matrix. Each option was evaluated against the project goals (shown below) in each row, on a scale of 1-4. Project specific goals that fit into the 4 overarching goals of flexibility, community, economy, and sustainability are color coded as such.

	Project Goals
1	Flexibility/ Adaptability to account for multiple space types/ locations
2	Prototypability of building/ ability to replicate in other locations
3	Recyclability of materials
4	Energy Saving Potential
5	Educational value
6	Economic use of materials
7	Maintainability of system for life span
8	Consideration of other systems (depth, size, etc.)
9	Specialized Market
10	Innovation

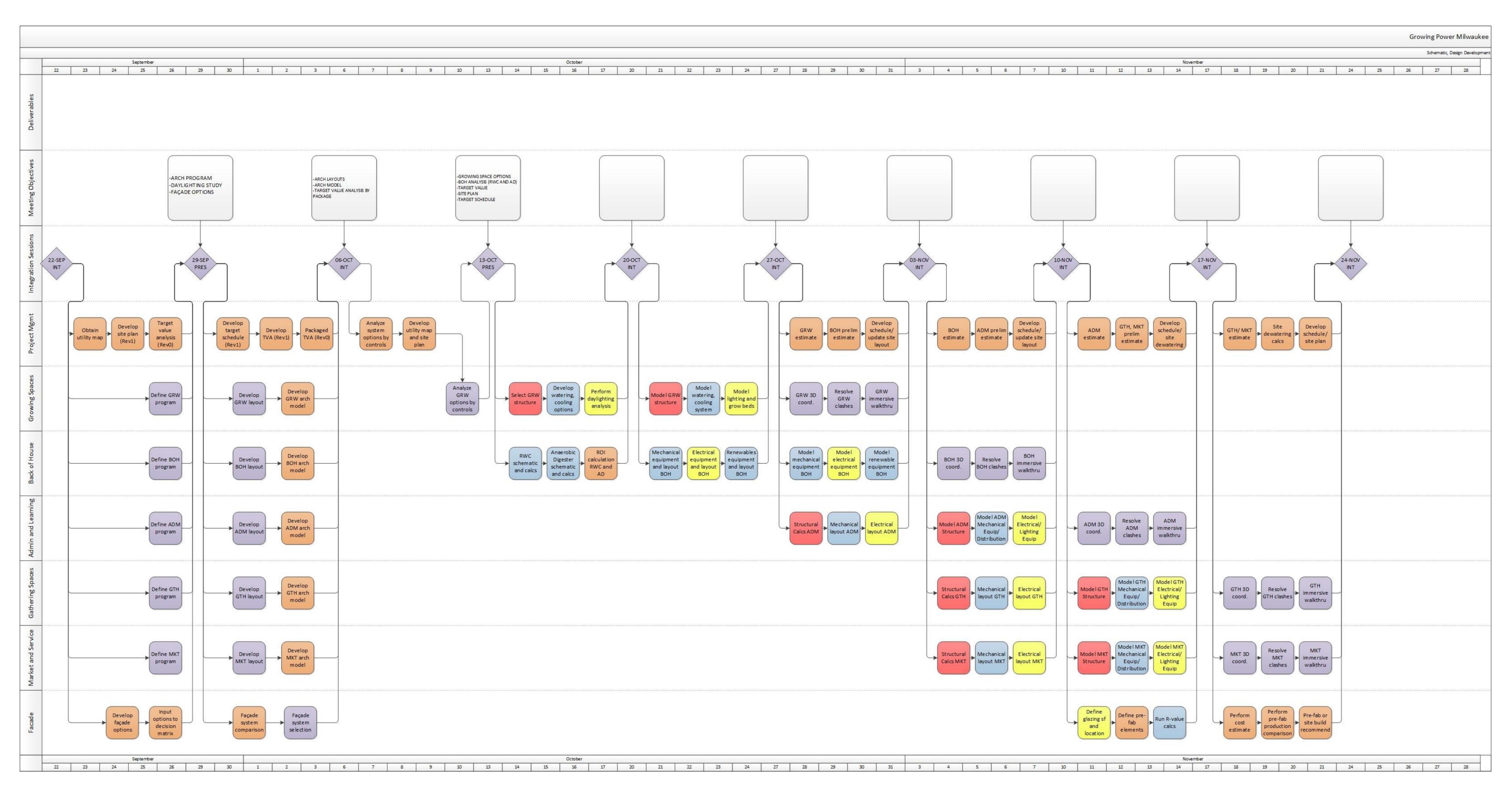








TBD ENGINEERING DESIGN SCHEDULE



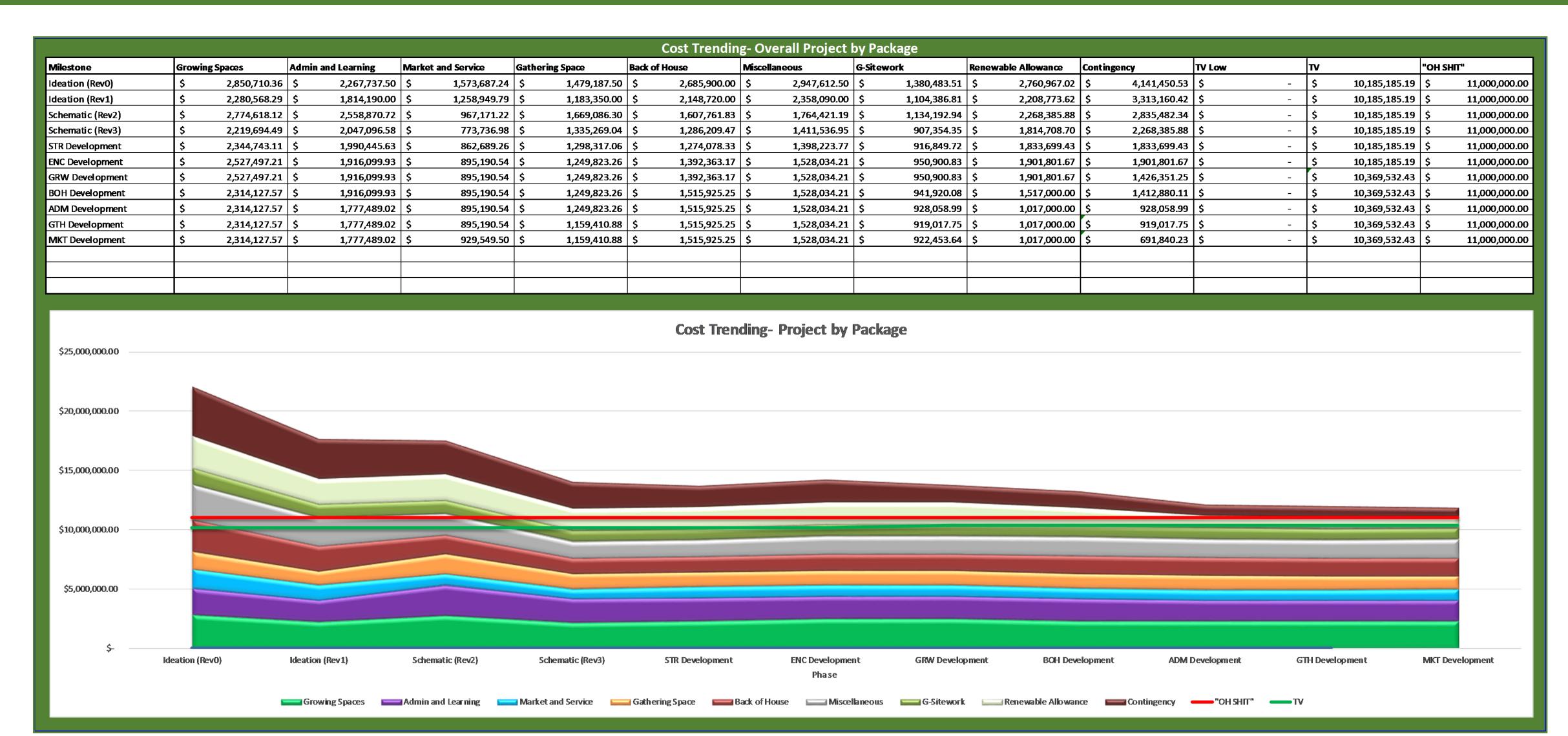
Throughout the design phases, TBD set milestones during detailed in the process map to the left. The process map into horizontal swimlanes according to the developed design packages contained in the Growing Power facility.

Tasks described in the process map are filled with a color to indicate the responsible partner; orange indicates management tasks, blue indicates mechanical tasks, yellow indicates electrical tasks, red indicates structural tasks, and purple indicates tasks that require input from all disciplines. Tasks can be seen displayed chronologically from left to right, in order of expected completion, to maintain a continuous, efficient workflow.

The process map was developed in parallel with TBD's collaborative planning sessions, as a way to visually represent the flow of the project's development. The map was continuously updated with each planning session, and displayed in the team's co-located office space to guide the team.



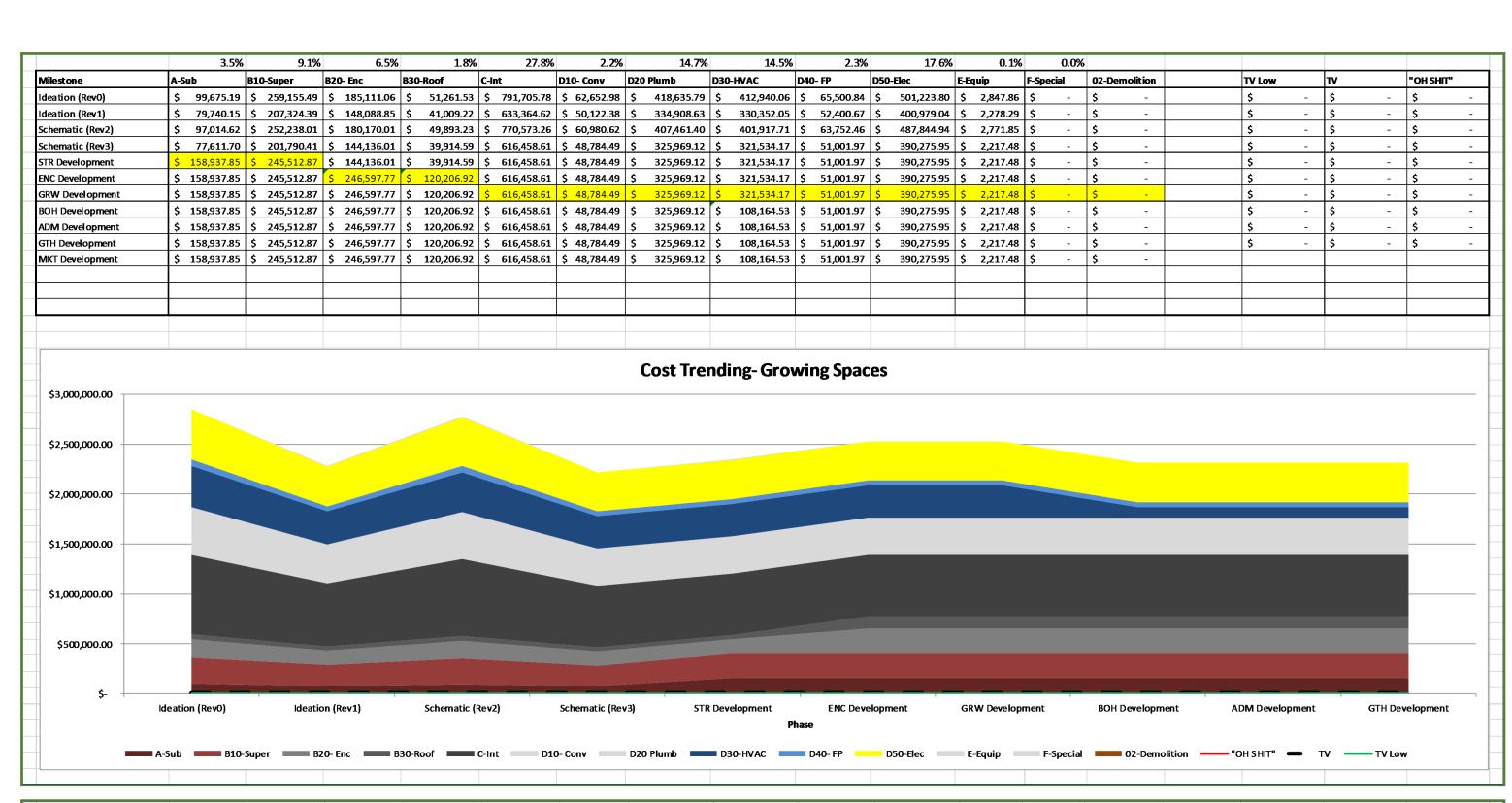
TBD ENGINEERING | COST TRENDING ANALYSIS

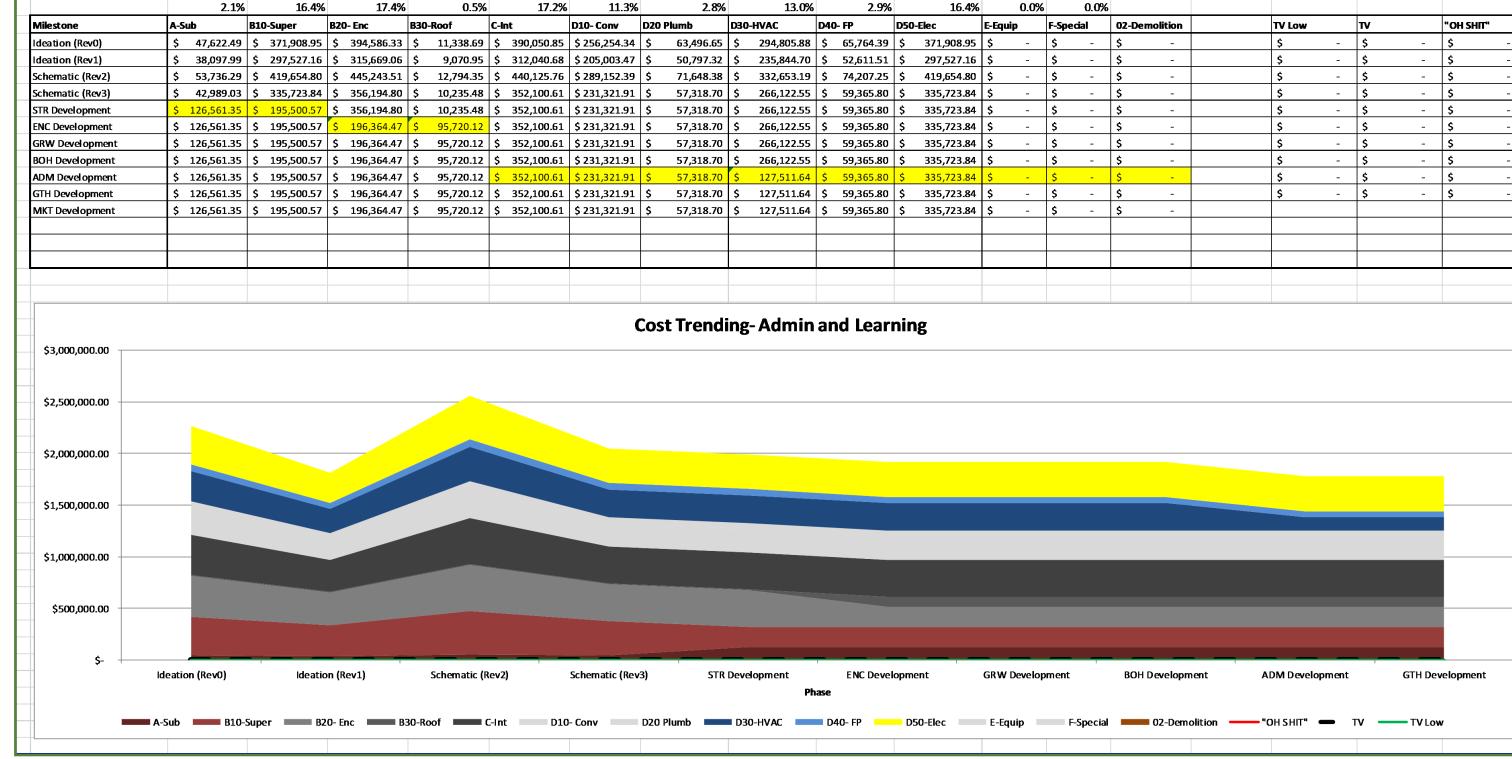


Cost Tracking- Overall Project by Division																
lilestone	A-Sub	B10-Super	B20- Enc	B30-Roof	C-Int	D10- Conv	D20 Plumb	D30-HVAC	D40- FP	D50	0-Elec	E-Equip	F-Special	G-Sitework	Renewables	Contingency
deation (Rev0)	\$ 1,426,785.68	\$ 1,623,176.63	\$ 1,746,423.53	\$ 504,338.10	\$ 2,146,776.19	\$ 486,055.50	\$ 826,798.61	\$ 1,393,387.	54 \$ 6	636,243.83 \$	2,492,143.24	\$ 190,329.04	\$ 332,377.24	\$ 1,380,483.5	1 \$ 2,760,967.02	\$ 4,141,450
deation (Rev1)	\$ 1,141,428.54	\$ 1,298,541.30	\$ 1,397,138.82	\$ 403,470.48	\$ 1,717,420.95	\$ 388,844.40	\$ 661,438.89	\$ 1,114,710.0	03 \$ 5	508,995.06 \$	1,993,714.59	\$ 152,263.23	\$ 265,901.79	\$ 1,104,386.8	1 \$ 2,208,773.62	\$ 3,313,160
chematic (Rev2)	\$ 935,318.04	\$ 1,396,450.90	\$ 1,464,346.71	\$ 332,387.89	\$ 1,927,299.51	\$ 538,739.76	\$ 708,072.52	\$ 1,248,630.	32 \$ 4	464,046.02 \$	2,012,656.89	\$ 115,022.03	\$ 198,958.80	\$ 1,134,192.94	4 \$ 2,268,385.88	\$ 2,835,482
chematic (Rev3)	\$ 748,254.43	\$ 1,117,160.72	\$ 1,171,477.37	\$ 265,910.31	\$ 1,541,839.60	\$ 430,991.81	\$ 566,458.02	\$ 998,904.2	26 \$ 3	371,236.82 \$	1,610,125.51	\$ 92,017.62	\$ 159,167.04	\$ 907,354.3	5 \$ 1,814,708.70	\$ 2,268,385
TR Development	\$ 770,370.25	\$ 1,189,998.5	5 \$ 1,171,477.37	\$ 265,910.31	\$ 1,541,839.60	\$ 430,991.81	\$ 566,458.02	\$ 998,904.2	26 \$ 3	371,236.82 \$	1,610,125.51	\$ 92,017.62	\$ 159,167.04	\$ 916,849.72	2 \$ 1,833,699.43	\$ 1,833,699
NC Development	\$ 770,370.25	\$ 1,189,998.5	5 \$ 1,195,257.05	\$ 582,641.80	\$ 1,541,839.60	\$ 430,991.81	\$ 566,458.02	\$ 998,904.2	26 \$ 3	371,236.82 \$	1,610,125.51	\$ 92,017.62	\$ 159,167.04	\$ 950,900.83	3 \$ 1,901,801.67	\$ 1,901,801
RW Development	\$ 770,370.25	\$ 1,189,998.5	5 \$ 1,195,257.05	\$ 582,641.80	\$ 1,541,839.60	\$ 430,991.81	\$ 566,458.02	\$ 998,904.2	26 \$ 3	371,236.82 \$	1,610,125.51	\$ 92,017.62	2 \$ 159,167.04	\$ 950,900.83	3 \$ 1,901,801.67	\$ 1,426,351
OH Development	\$ 770,370.25	\$ 1,189,998.5	5 \$ 1,195,257.05	\$ 582,641.80	\$ 1,541,839.60	\$ 430,991.81	\$ 566,458.02	\$ 909,096.	70 \$ 3	371,236.82 \$	1,610,125.51	\$ 92,017.62	2 \$ 159,167.04	\$ 941,920.08	8 \$ 1,517,000.00	\$ 1,412,880
DM Development	\$ 770,370.25	\$ 1,189,998.5!	5 \$ 1,195,257.05	\$ 582,641.80	\$ 1,541,839.60	\$ 430,991.81	\$ 566,458.02	\$ 770,485.	78 \$ 3	371,236.82 \$	1,610,125.51	\$ 92,017.62	\$ 159,167.04	\$ 928,058.99	9 \$ 1,017,000.00	\$ 928,058
TH Development	\$ 770,370.25	\$ 1,189,998.5	5 \$ 1,195,257.05	\$ 582,641.80	\$ 1,541,839.60	\$ 430,991.81	\$ 566,458.02	\$ 680,073.4	41 \$ 3	371,236.82 \$	1,610,125.51	\$ 92,017.62	\$ 159,167.04	\$ 919,017.7	5 \$ 1,017,000.00	\$ 919,017
/IKT Development	\$ 770,370.25	\$ 1,189,998.5	5 \$ 1,195,257.05	\$ 582,641.80	\$ 1,541,839.60	\$ 430,991.81	\$ 566,458.02	\$ 714,432.	36 \$ 3	371,236.82 \$	1,610,125.51	\$ 92,017.62	\$ 159,167.04	\$ 922,453.64	4 \$ 1,017,000.00	\$ 691,840
20,000,000.00																
15,000,000.00																
510,000,000.00																
\$5,000,000.00																
\$-	deation (Rev0)	Ideation (Rev1)	Schematic	c (Rev2)	Schematic (Rev3)	STR Develop	nent ENC	: Development	GRW D	Development	BOH Dev	elopment	ADM Development	GTH Develo	pment MKT	Development

In order to continually evaluate project costs against their targets, an in-depth analysis was devised. The overall project tracked designed costs by Integrated Design Packages and by Uniformat II divisions, shown to the left. The 6 IDPs were broken down further by Uniformat II divisions, with examples shown below. The multi-layer approach allowed TBD to quickly identify alarming trends through the course of the project's development and utilize cost as an informant to design, rather than a "design now, estimate later" approach which, more often than not, results in cost cutting techniques rather than truly engineering value as defined by the ownership partners at Growing Power.

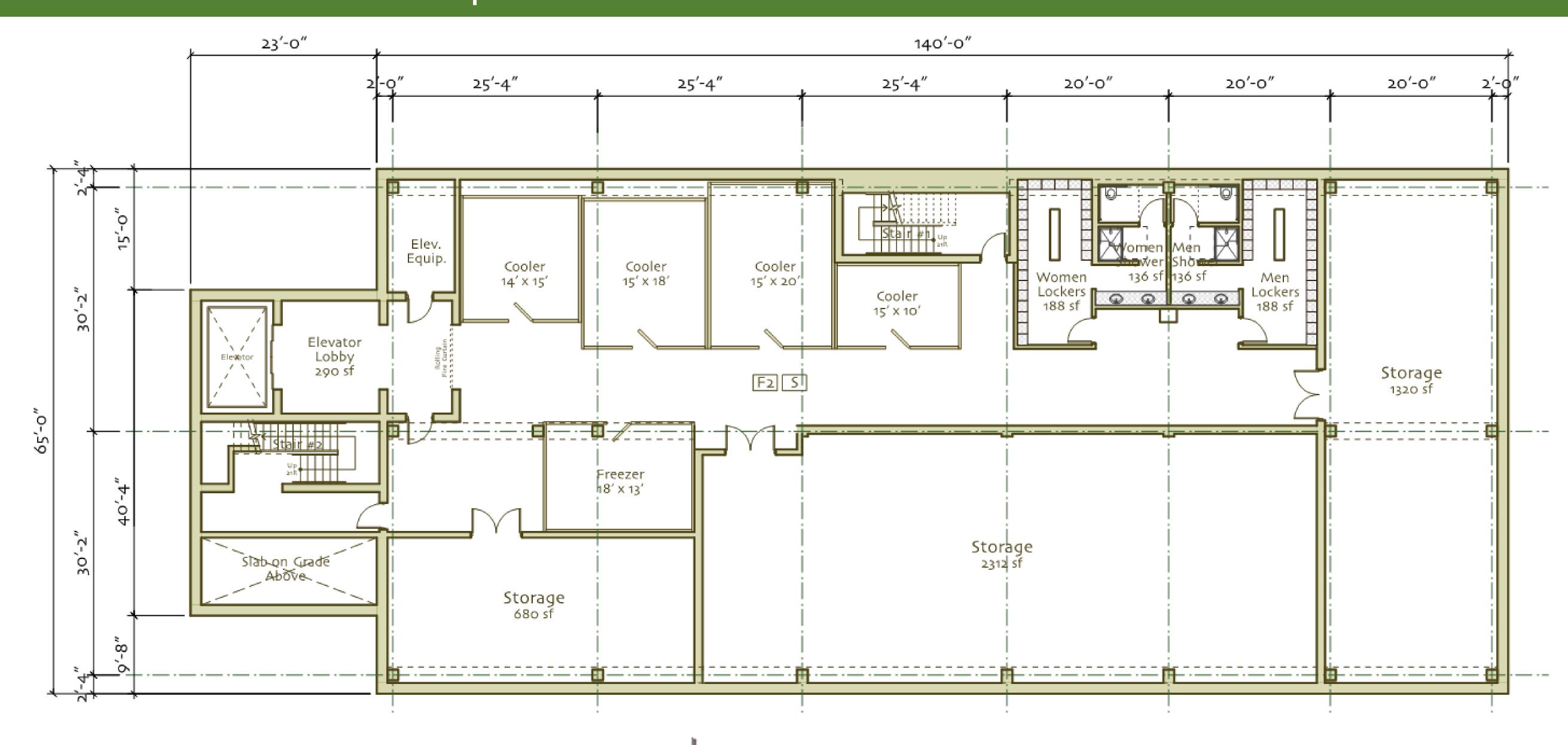
At the end of the project's development, the project estimate stood at a value of \$11.9 million, including a \$1 million allowance for a Combined Heat and Power plant in the Back of House area, and rainwater and groundwater harvesting systems.





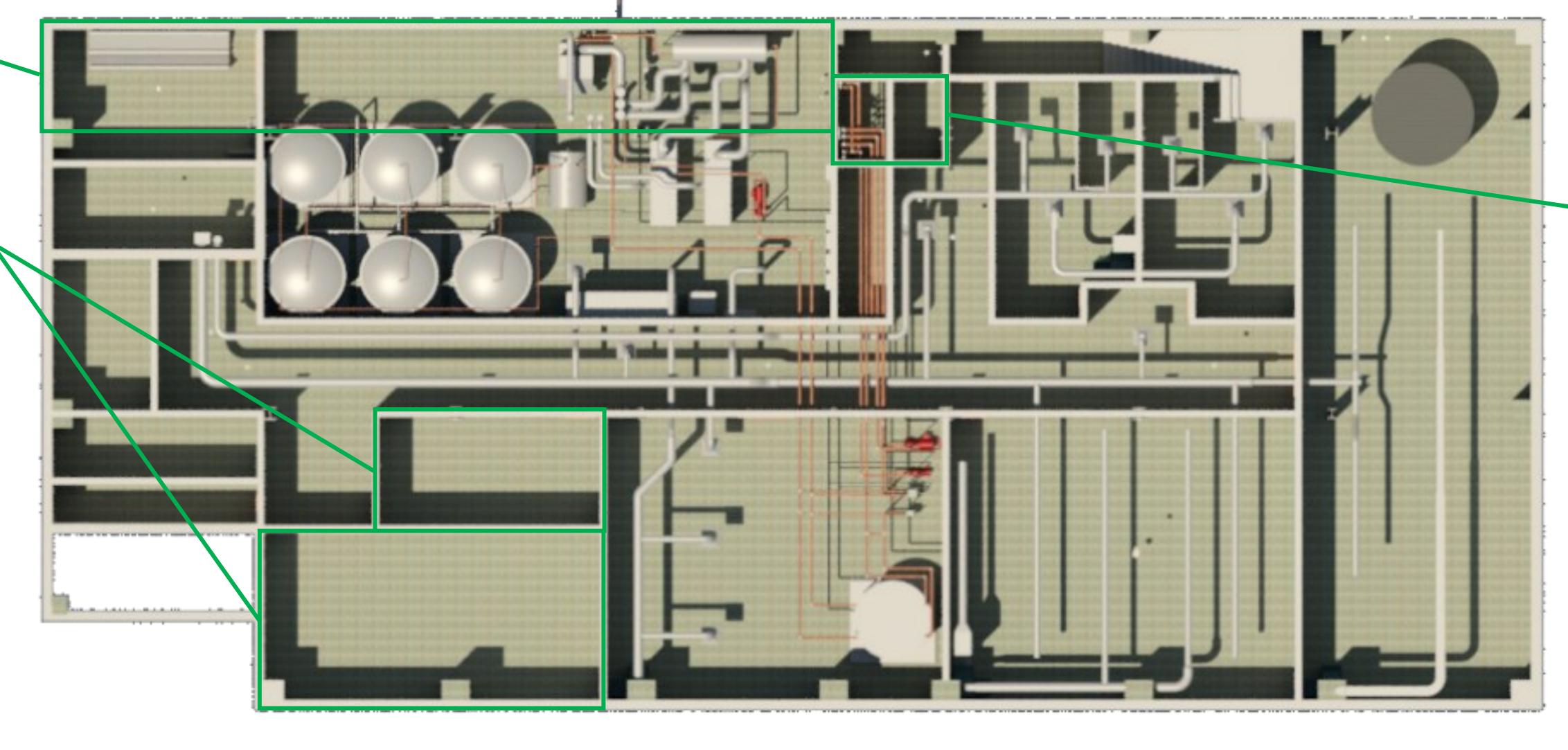


TBD ENGINEERING BASEMENT FLOOR PLAN



Mechanical Room Expansion -

Freezer and Cooler Storage

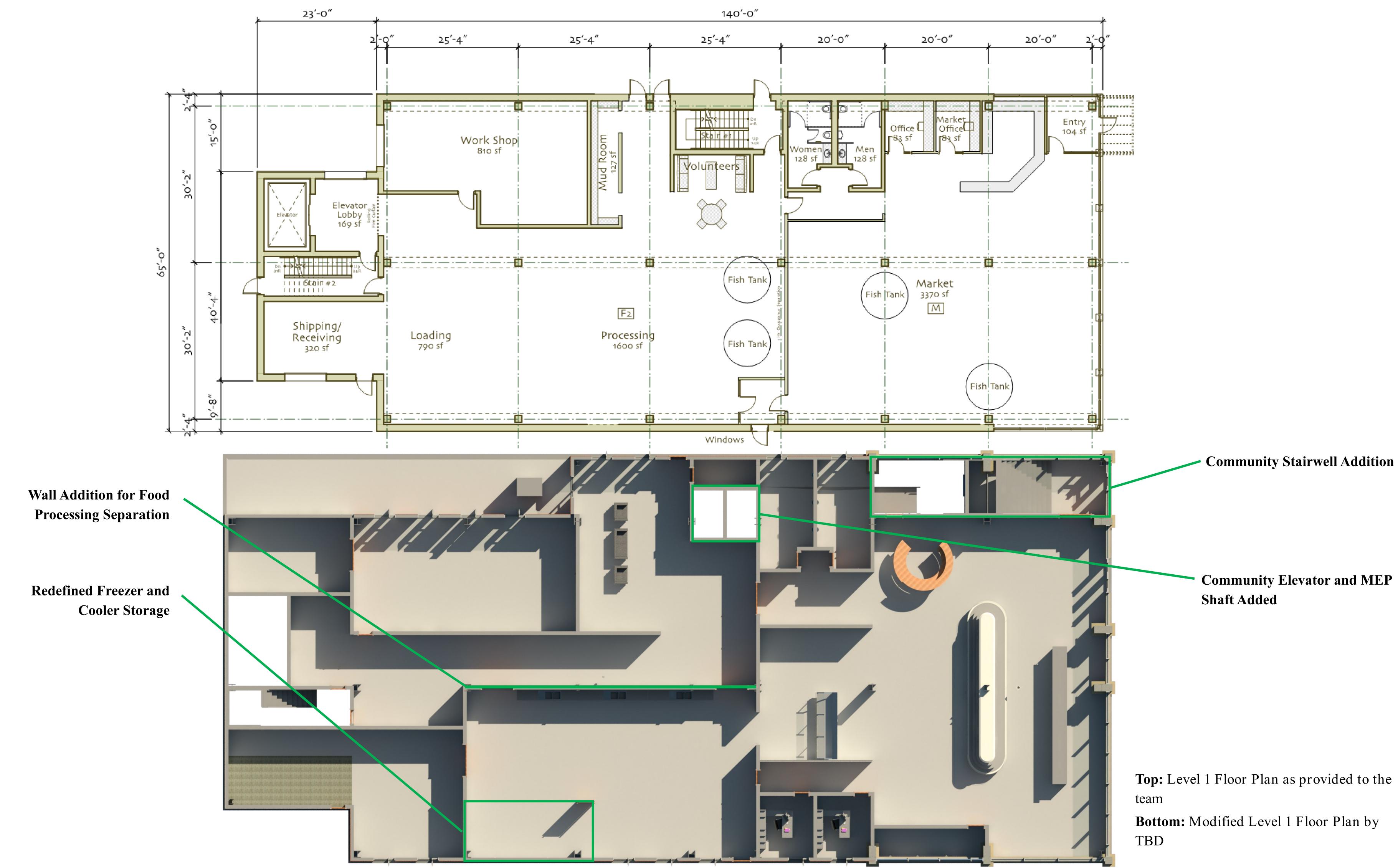


Community Elevator and MEP Shaft Added

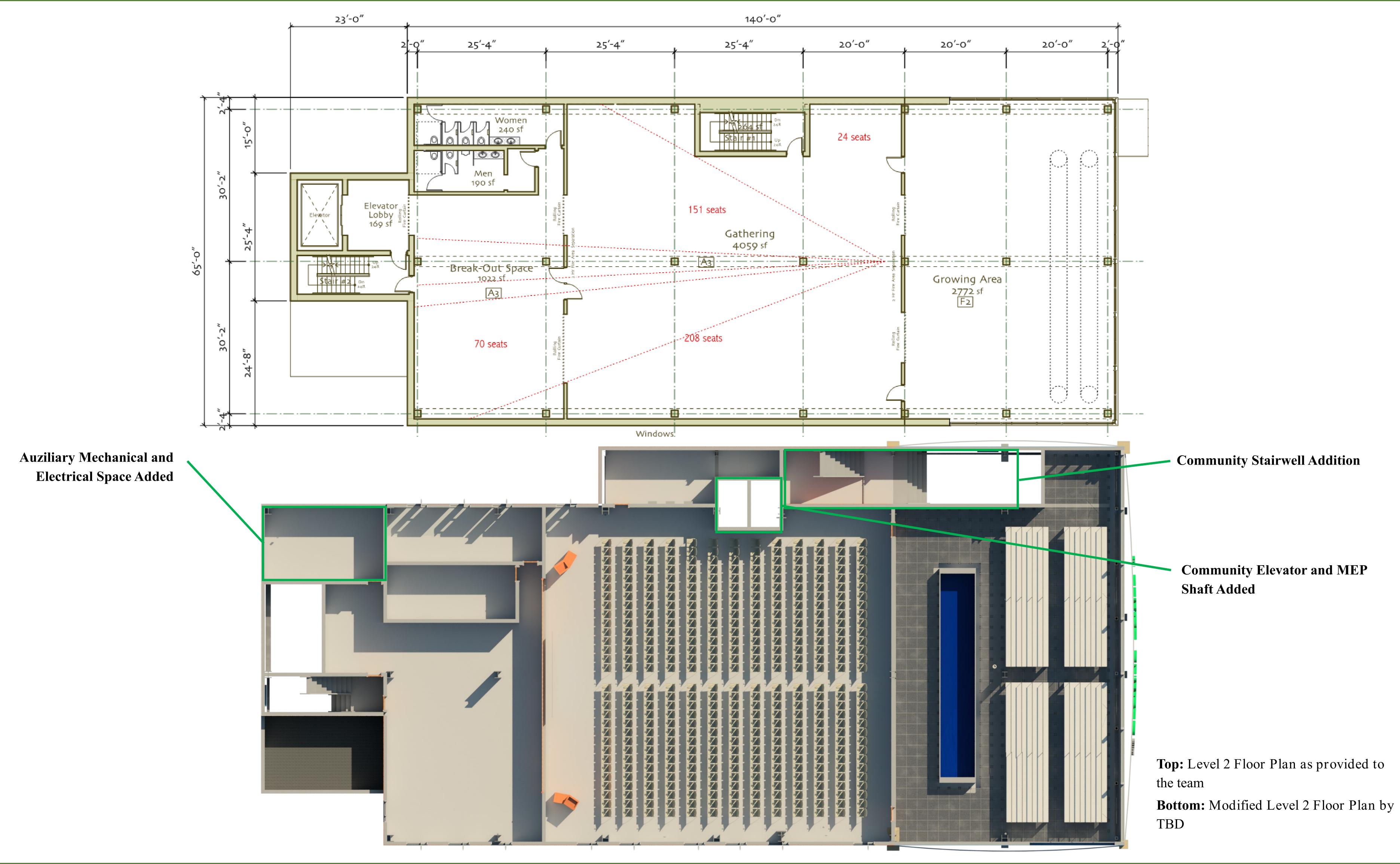
Top: Basement Floor Plan as provided to the team

Bottom: Modified Basement Floor Plan by TBD

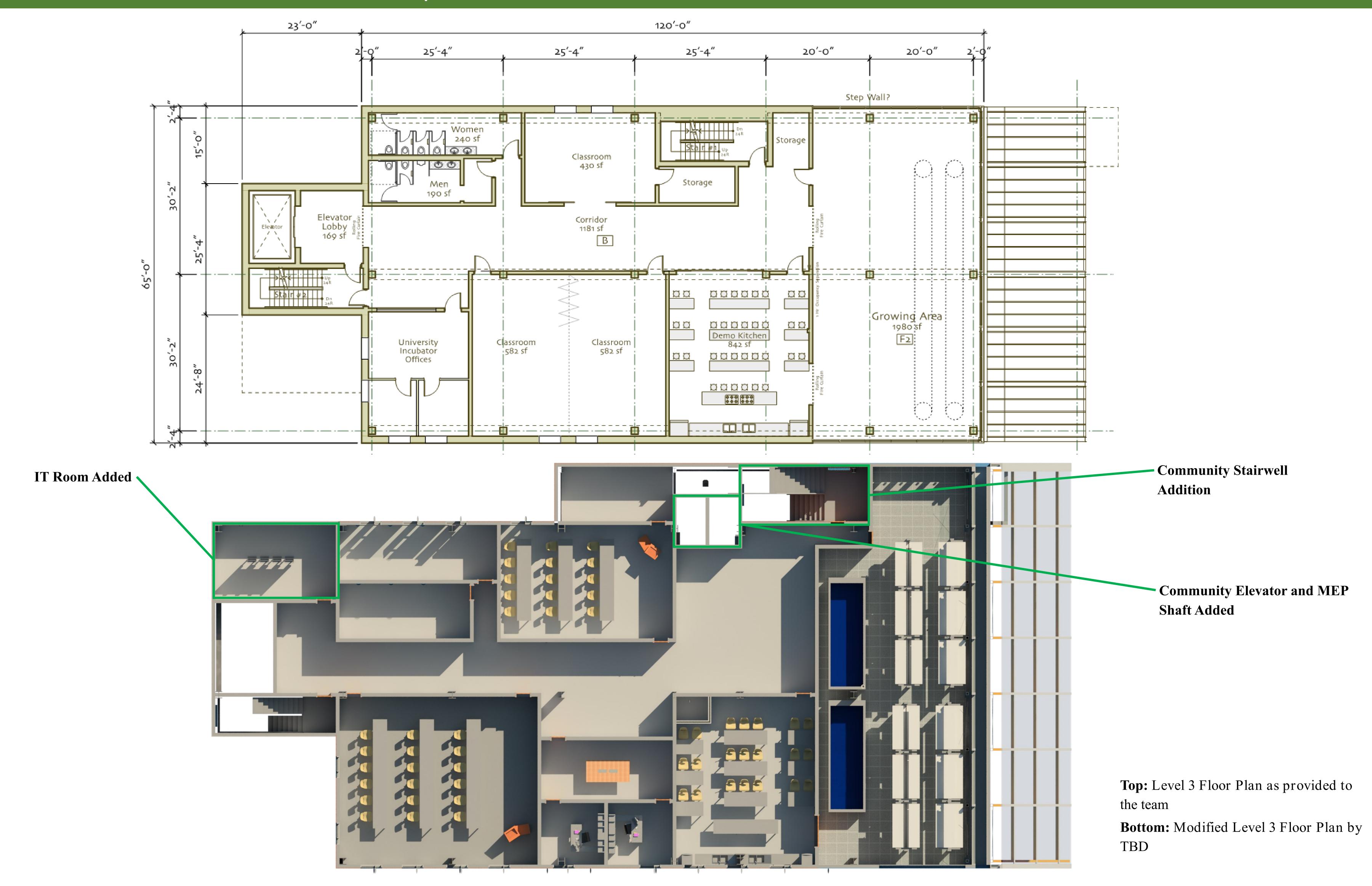
TBD ENGINEERING LEVEL 1 FLOOR PLAN



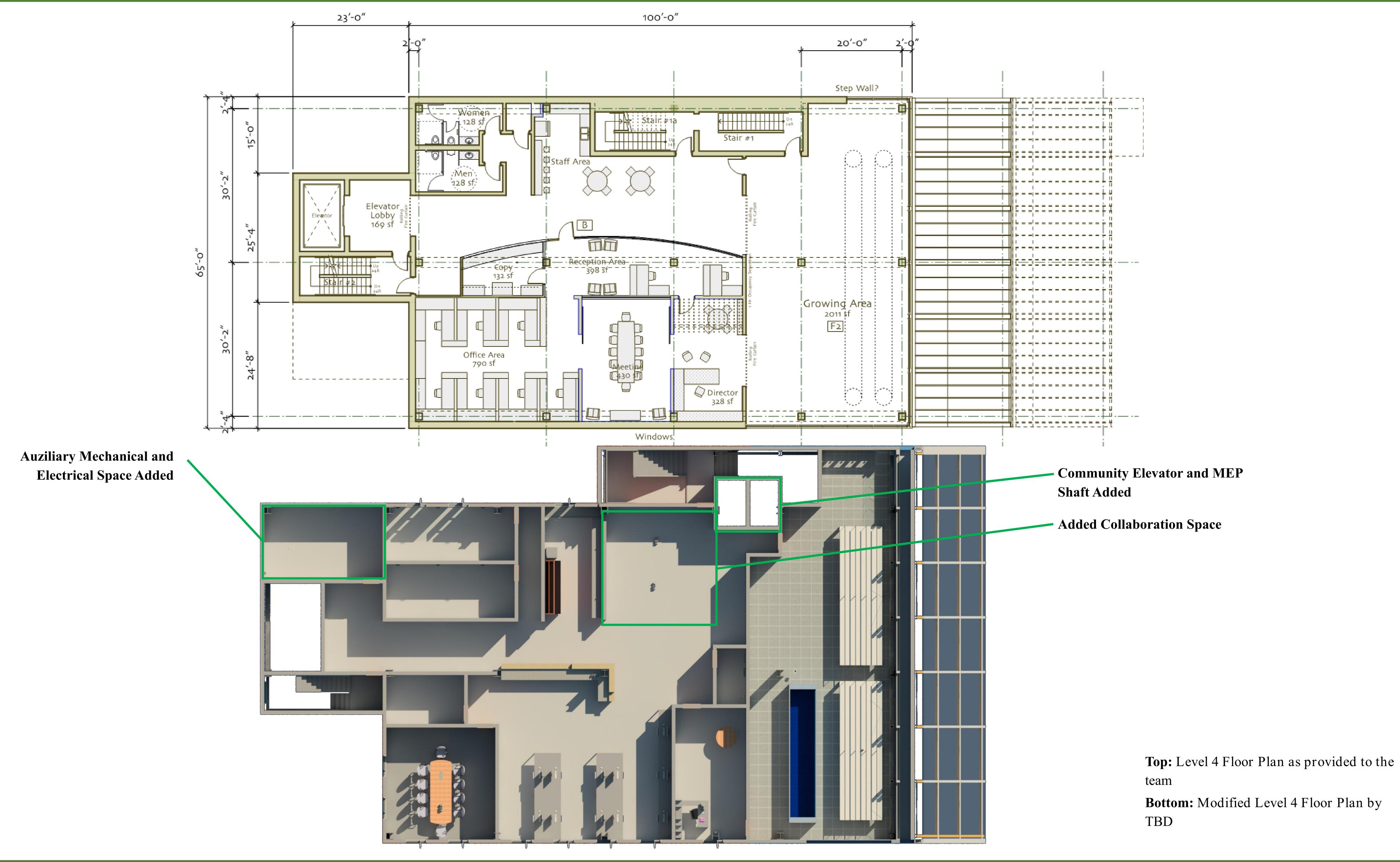
TBD ENGINEERING | LEVEL 2 FLOOR PLAN



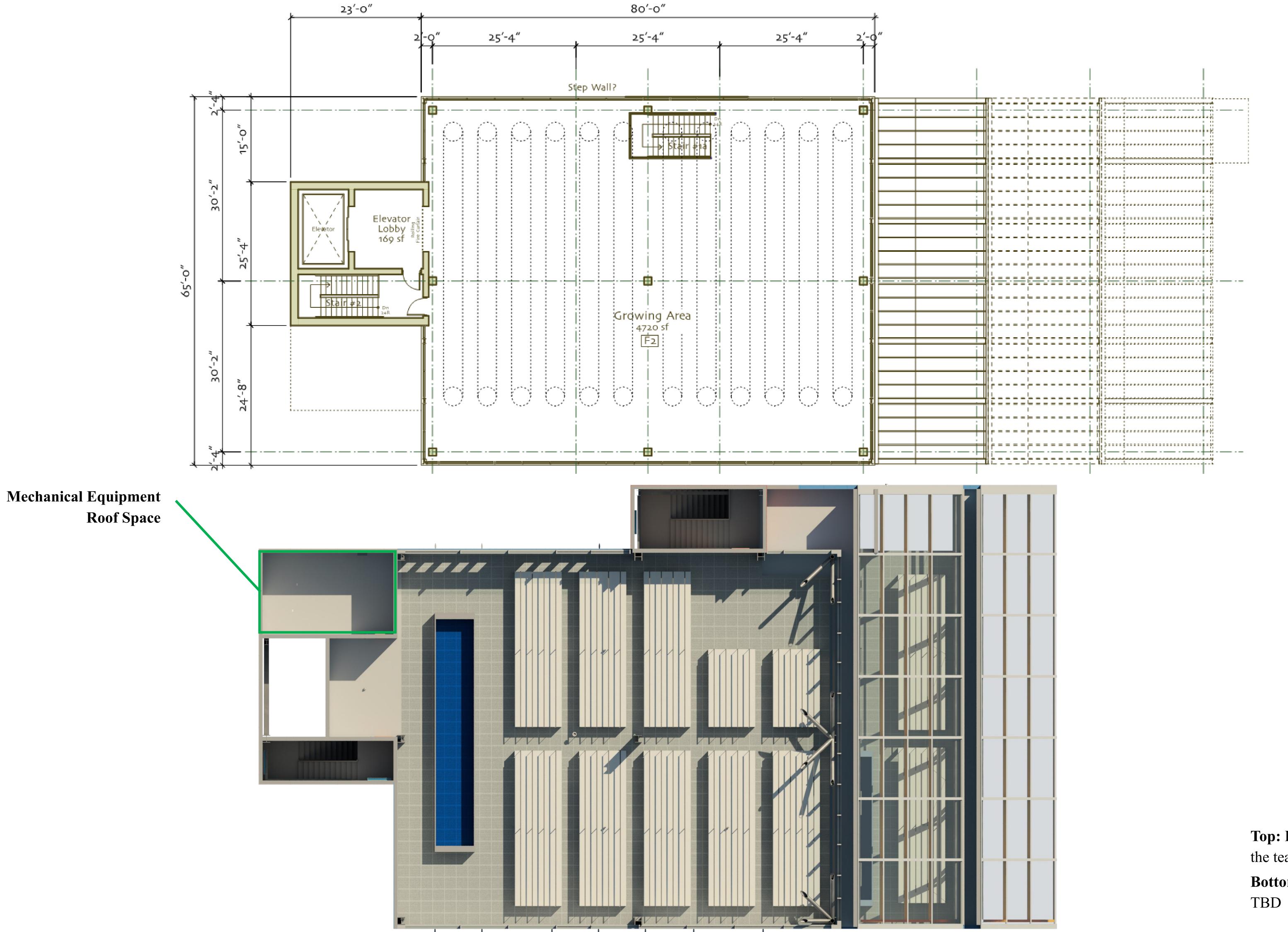
TBD ENGINEERING | LEVEL 3 FLOOR PLAN



TBD ENGINEERING | LEVEL 4 FLOOR PLAN



TBD ENGINEERING | LEVEL 5 FLOOR PLAN



Top: Level 5 Floor Plan as provided to the team

Bottom: Modified Level 5 Floor Plan by