River Team 2012

Nick	Yao	Mike	Tom	Maria	Nicholas
					
E	E	CM	E	LCFM	A

Owners

Weimar, Germany

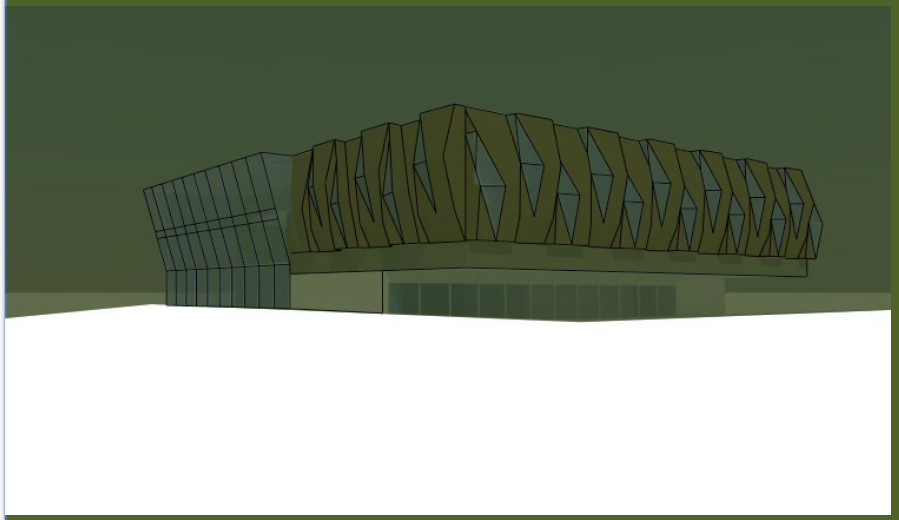
Bauhaus- University Weimar

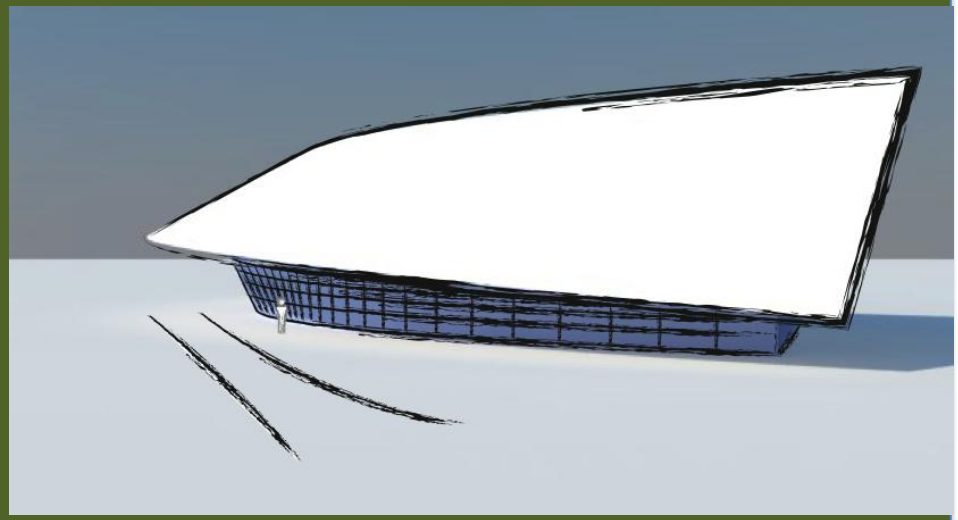
New campus building

Architecture

Team Member

Nicholas





Site Conditions

Weimar, Germany

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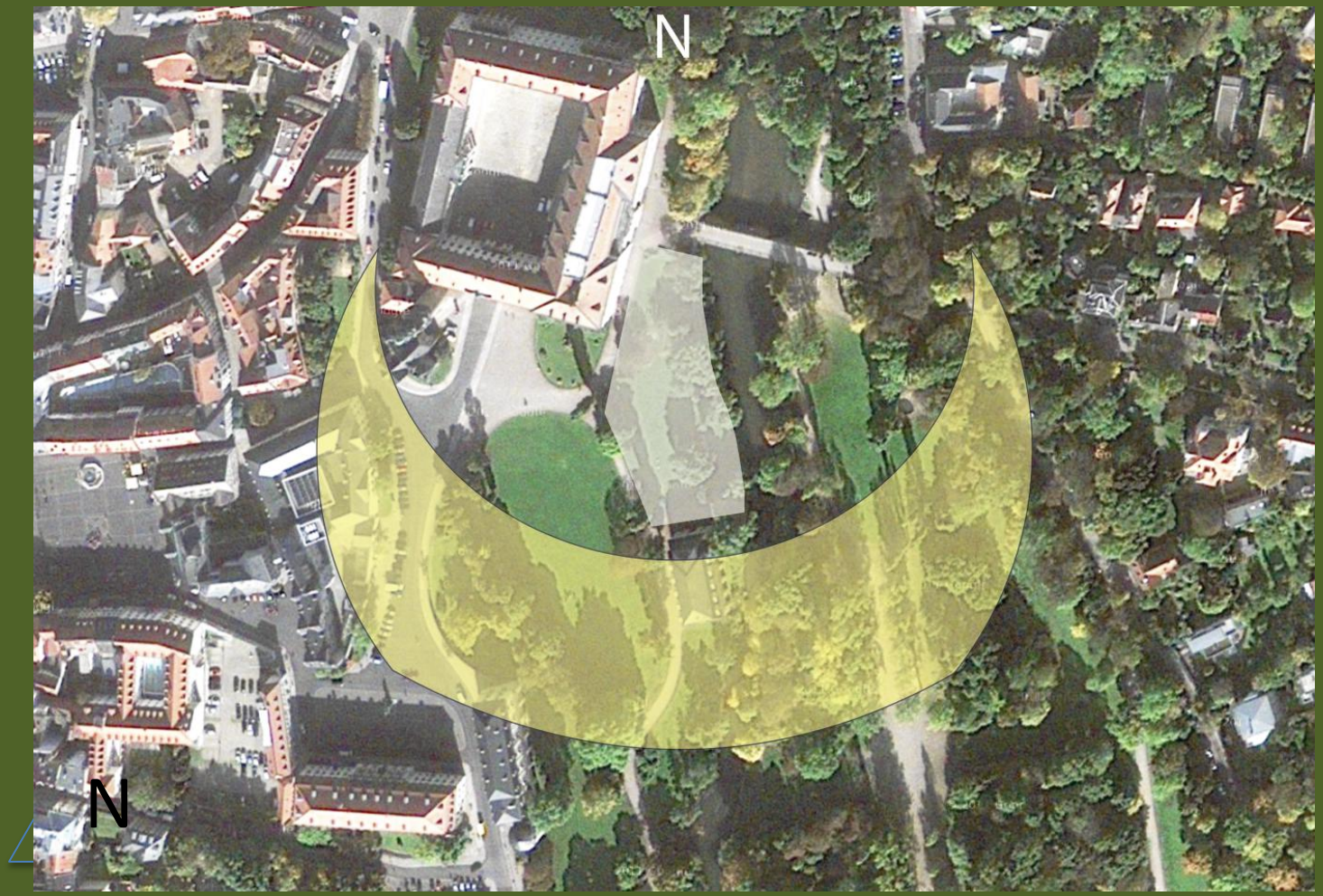
Sun path on site



Site conditions

WEIMAR AVERAGE WEATHER BY MONTH

Month	Temperature °F				Average Rainfall (mm)		Average snow days	Average Fog days
	Average		Absolute		Daily	Monthly		
	max	min	max	min				
January	38.1	27.9	58.3	-4.4	0.5	16.5	0	0
February	41.7	30.0	66.0	-1.7	0.7	20.7	-280	-280
March	48.2	33.6	71.2	12.6	1	29.5	-310	-310
April	57.4	37.9	80.6	18.1	0.6	19.1	-300	-300
May	66.4	45.9	90.5	30.7	0.7	21.6	0	0
June	71.8	50.9	92.3	38.5	0.8	24.9	-300	-300
July	74.5	54.7	95.7	43.7	1.4	44.5	-310	-310
August	75.0	54.5	95.9	39.4	0.8	25.3	-310	-310
September	67.1	48.6	85.8	31.6	0.6	19.4	-300	-300
October	56.8	42.4	77.9	18.7	0.9	27.6	-310	-310
November	45.9	35.4	66.4	14.9	1.1	32.6	-300	-300
December	39.4	30.0	57.6	7.5	0.7	21.9	-310	-310

Challenges

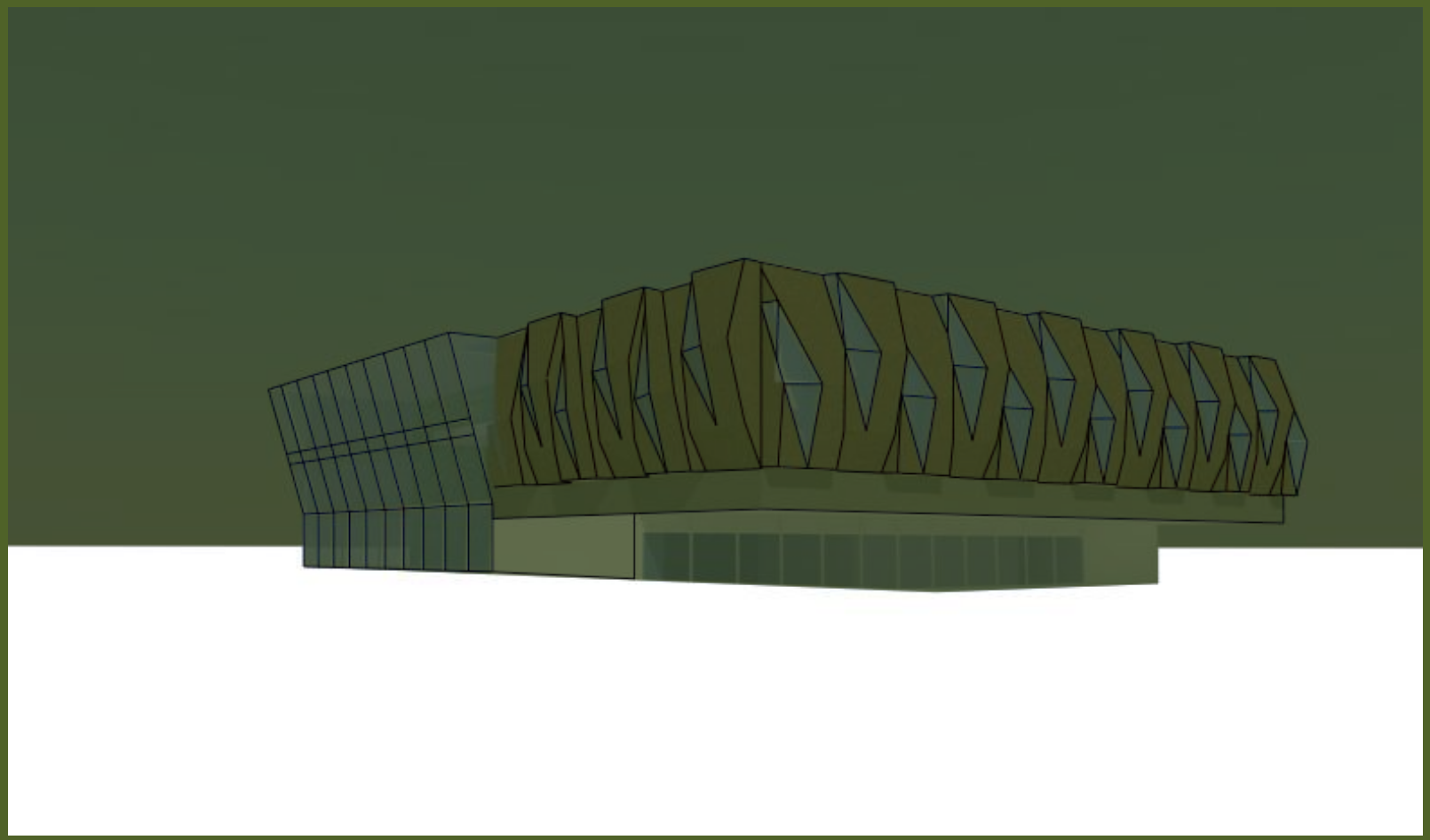
Challenges and goals set for the group

Flooding

Net-energy zero

Trees on site

Green box



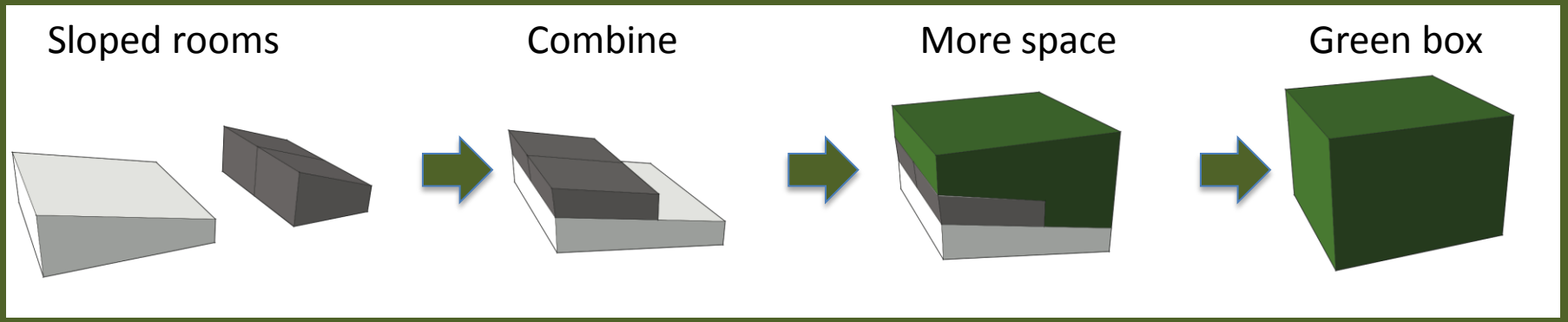
architecture | structure | construction | mep | life cycle financial management

Bio Mimicry

Moss - Biowall

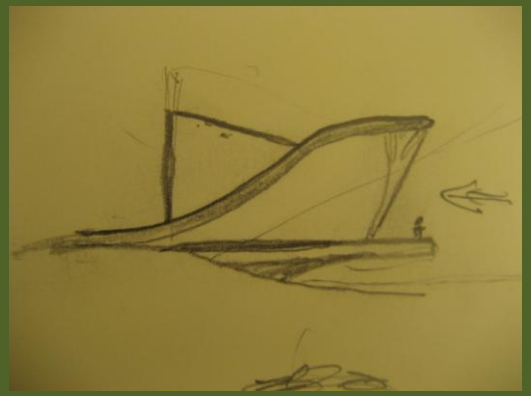
Big idea

It all started with an idea



Iterations

Evolution of the design

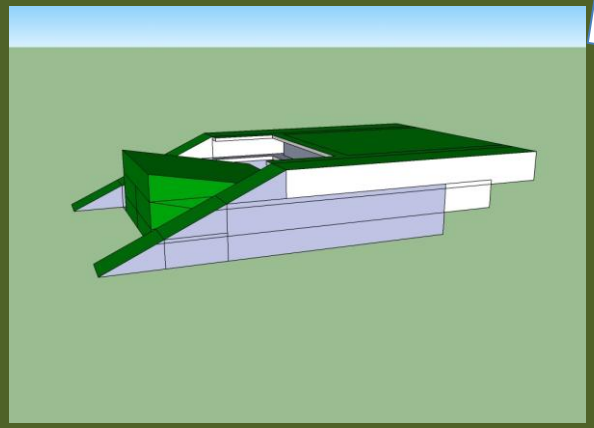


From Analog to digital

Allocating the spaces

A

Iteration 1

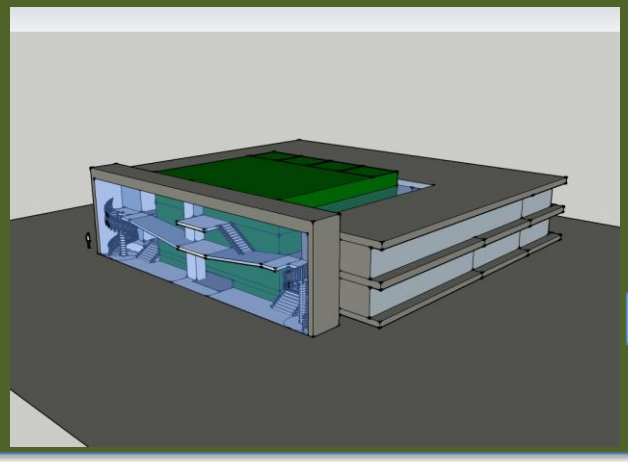


Working with the cantilever

AE

Iteration 2

Expensive biowall/ wasted spaces



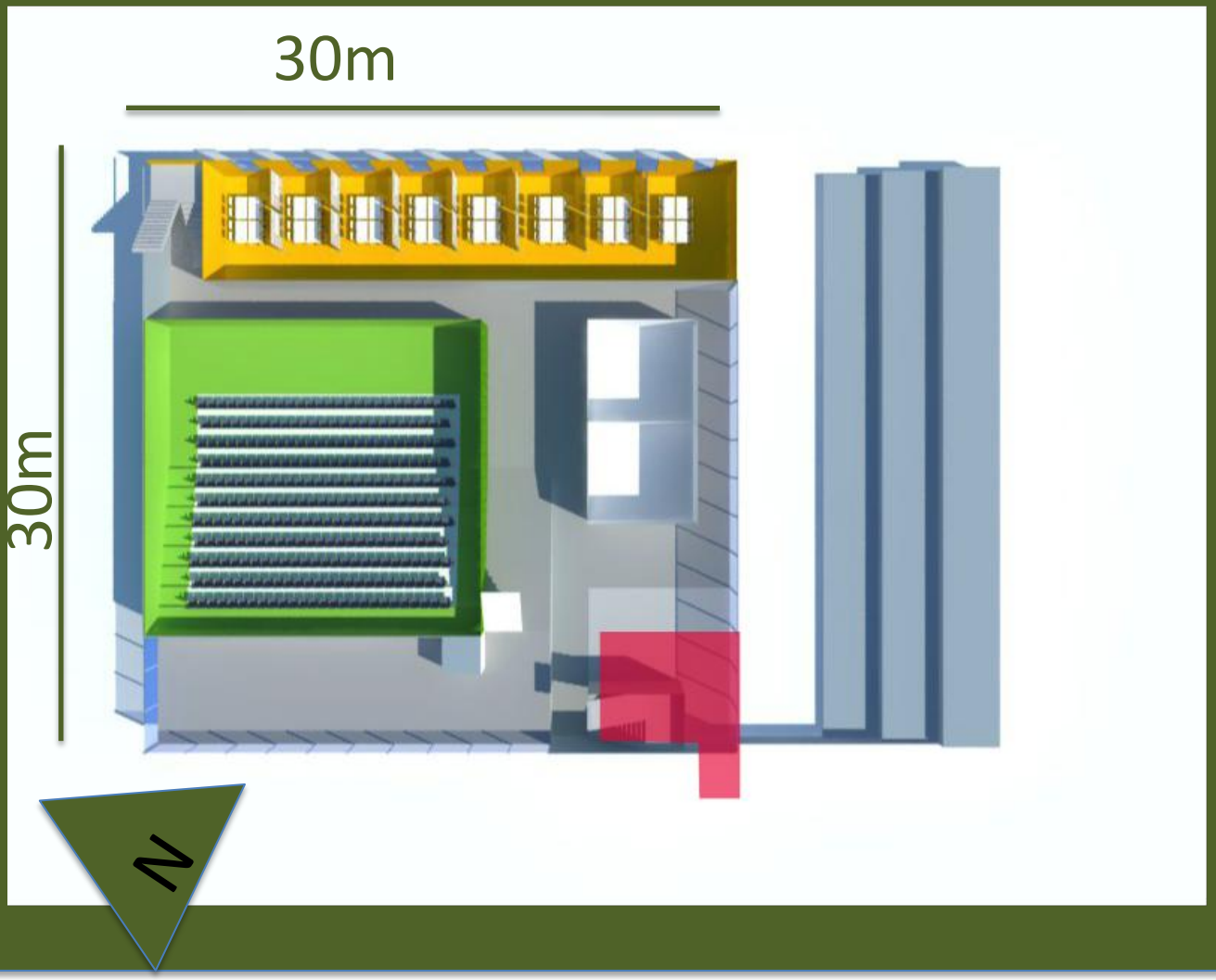
ACLCFM

Iteration 3

Green Box

3D overview + Site orientation

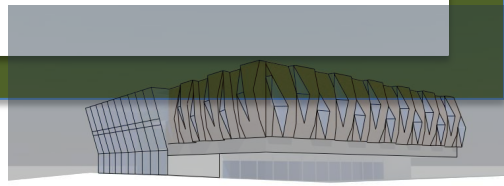
1st floor



Student offices	170 m2
Auditorium	280 m2
Storage	90 m2
Restrooms	60 m2
Footprint	935 m2

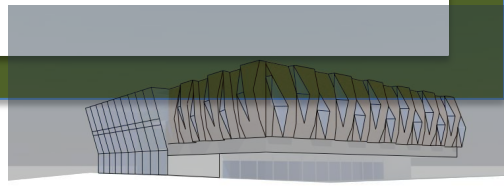
2nd floor

Instructional Labs	184 m2
Small Classrooms	187 m2
Large classrooms	148 m2
Department chair	27 m2
Senior assistent	27 m2
MEP Room	30 m2

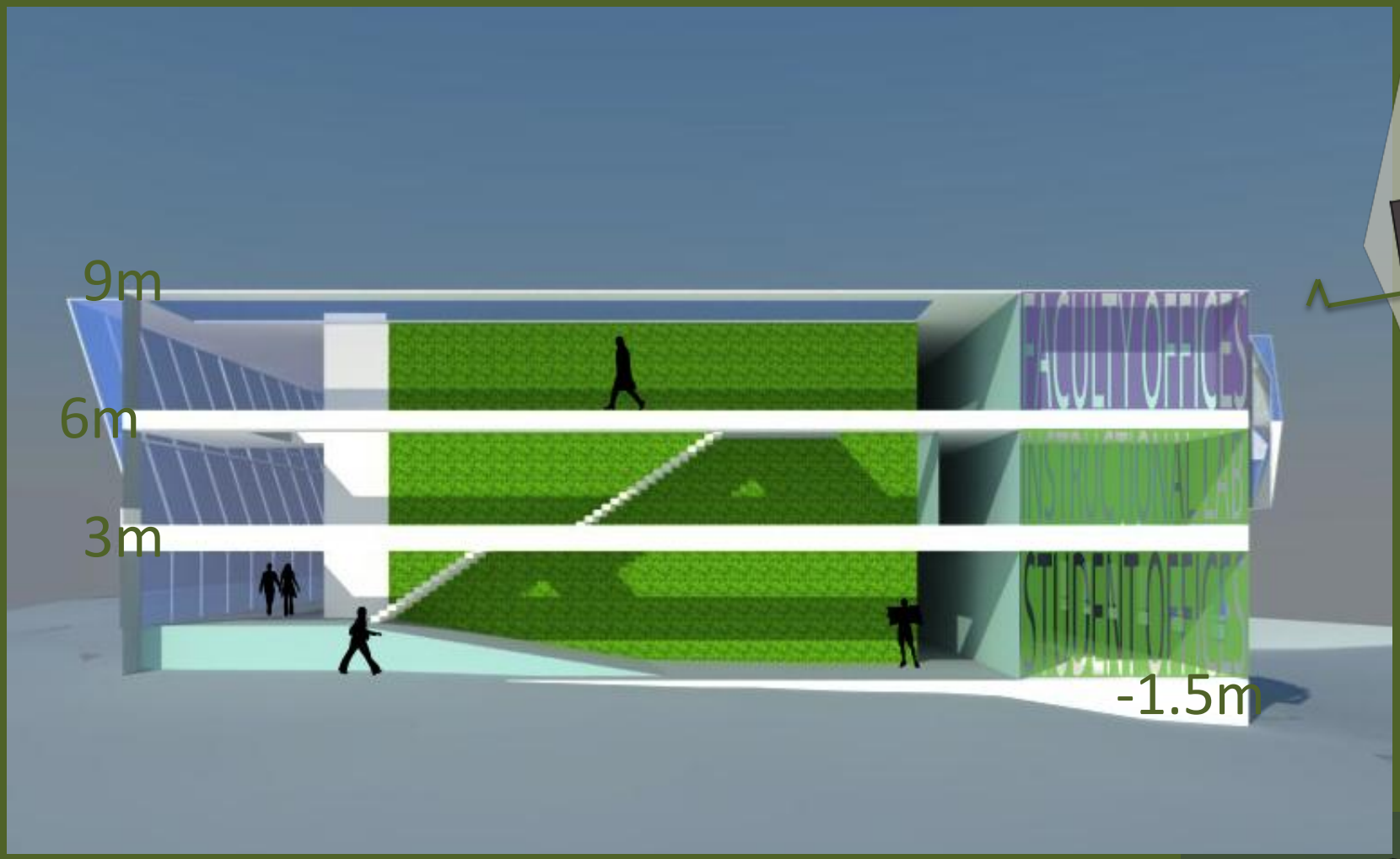


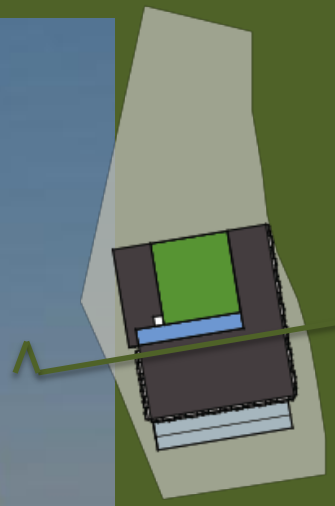
3rd floor

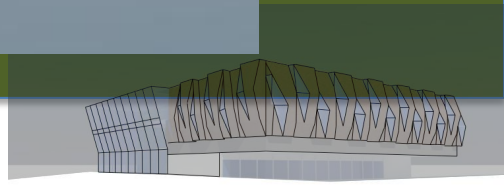
Faculty offices	334 m2
Faculty lounge	94 m2
Assistents	27 m2



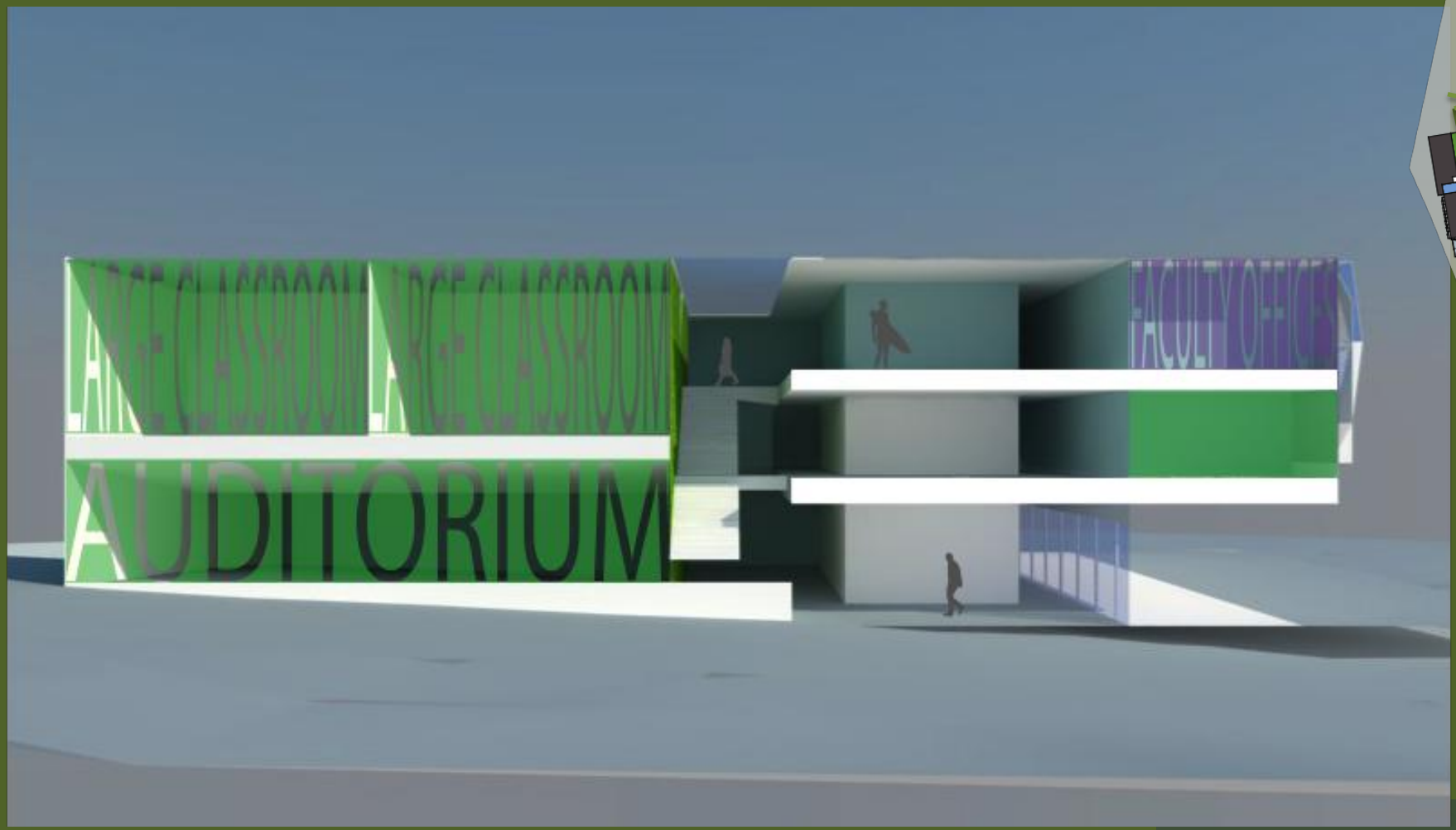
Section A

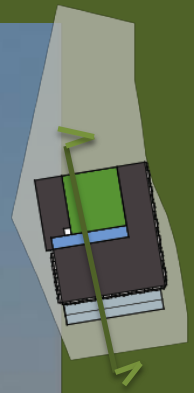

9m
6m
3m
-1.5m
FACULTY OFFICES
INSTRUCTIONAL LAB
STUDENT OFFICES

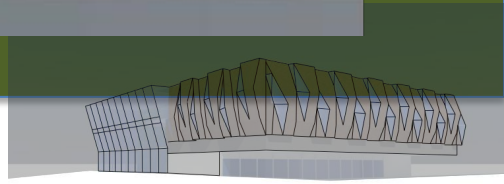




Section B

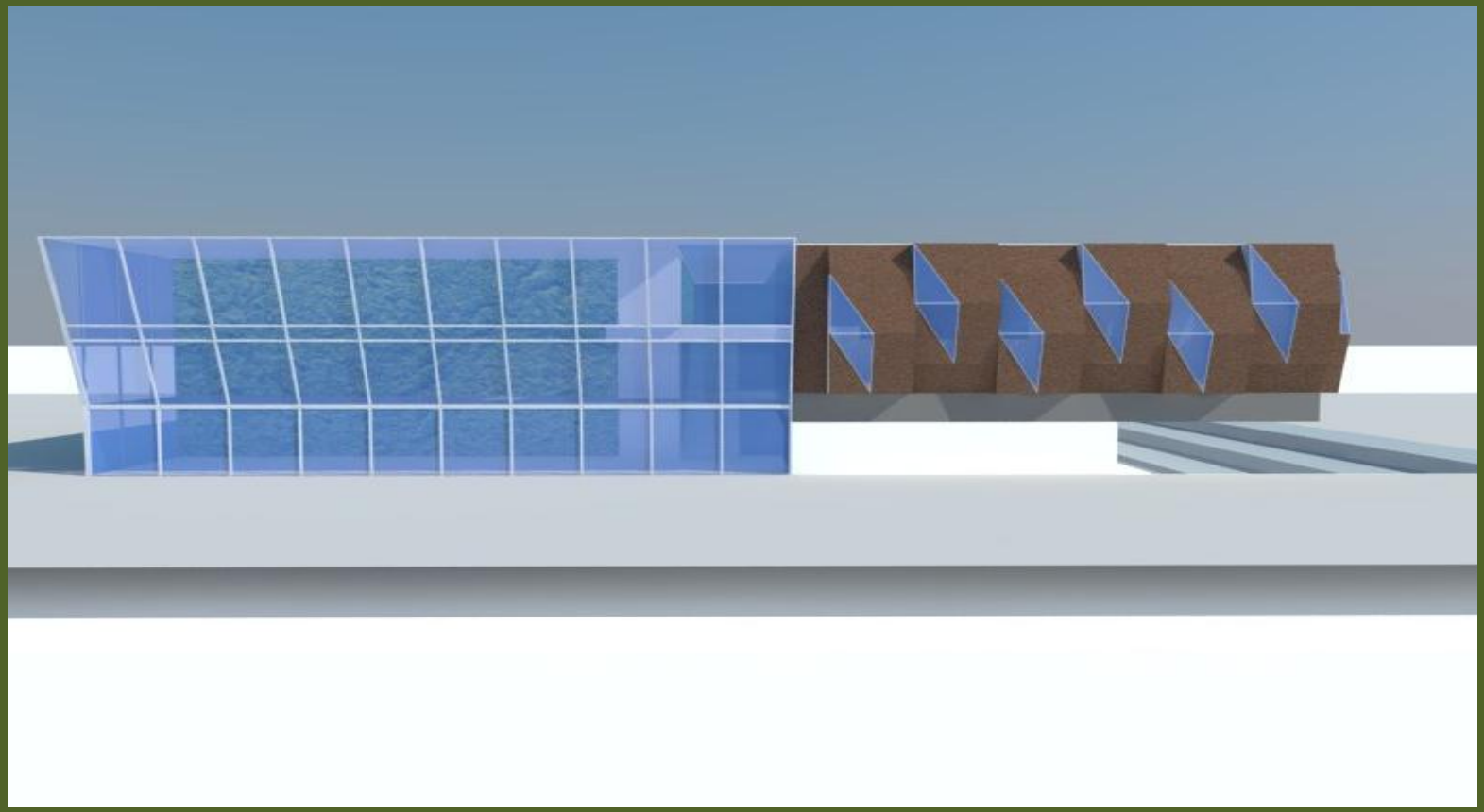

LARGE CLASSROOM
LARGE CLASSROOM
AUDITORIUM
FACULTY OFFICES





Green Box- Structural

Structural Options:
- Concrete
- Steel



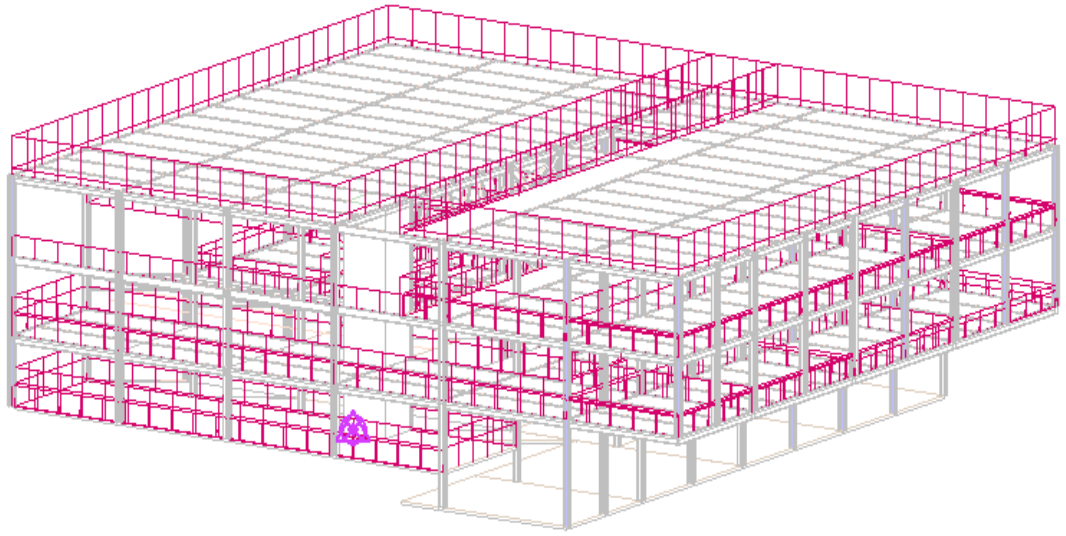
Loading

Standards:
International Building Code

Using Load and Resistance Factor Design (LRFD)

LC1➔ 1.4 D
LC2 ➔ 1.2 D +1.6 L + 0.5L_r
LC3➔1.2 D + 1.6L_r +1.0 L + .8W

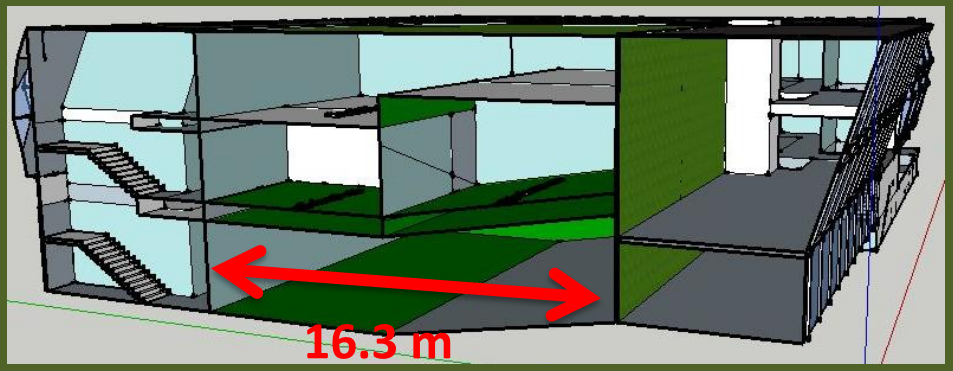
	kN/m^2	psf
Labs	4.8	100
Classrooms	1.9	40
Offices	2.4	50
Roof	1.9	40
Hallway	3.8	80
Area Dead	1.67	35
Snow	**0.83**	**17**
Windward	**0.64**	**13.36**
Leeward	**0.37**	**7.7**

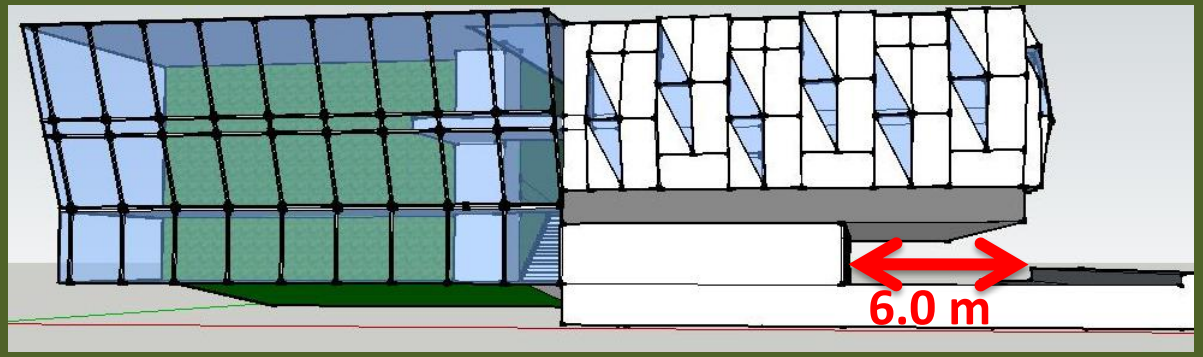


Design Challenges

Two Main Challenges:

- Clear space of 16.3m (53ft) x 17.3m (57ft) in the auditorium on the first floor
- 6m (20ft) cantilever on the second and third floor on the east side



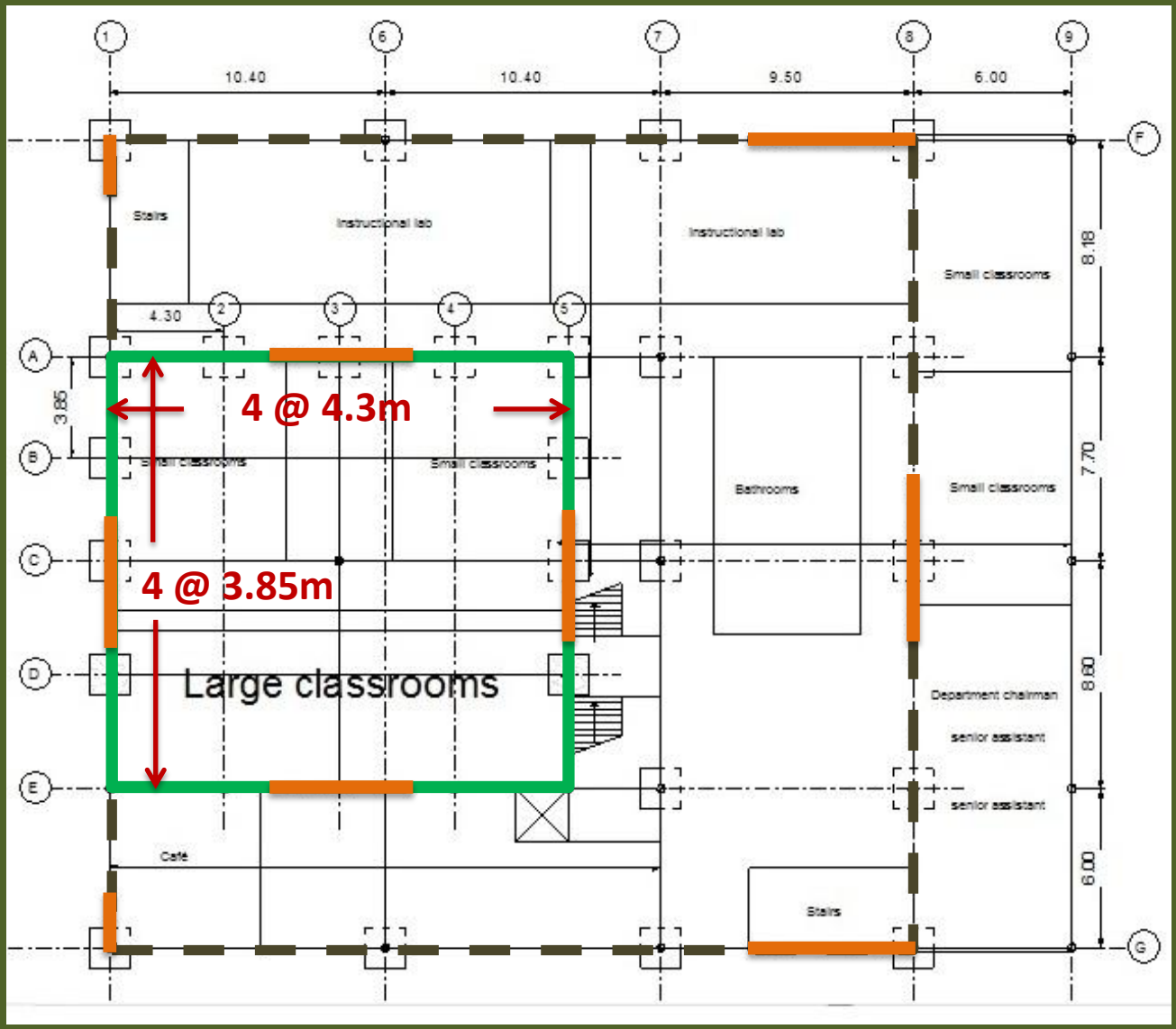


Green Box- Concrete

Structural Plan and Grid

Two sub structures:

- Green Box
- Periphery



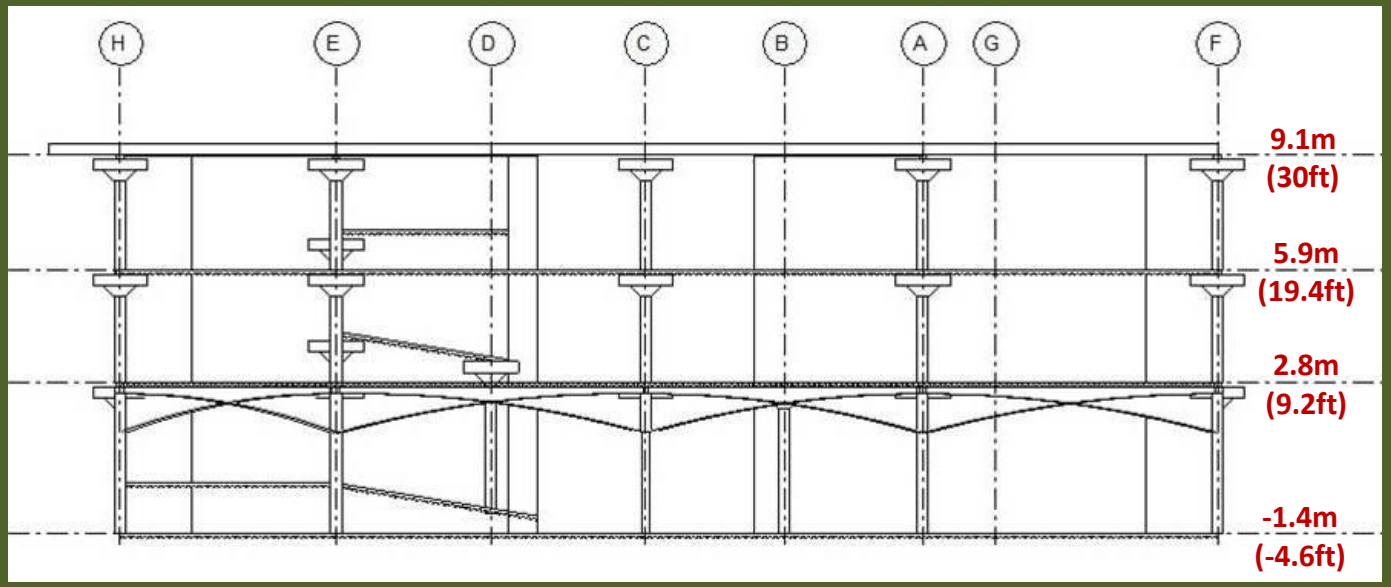
Footprint

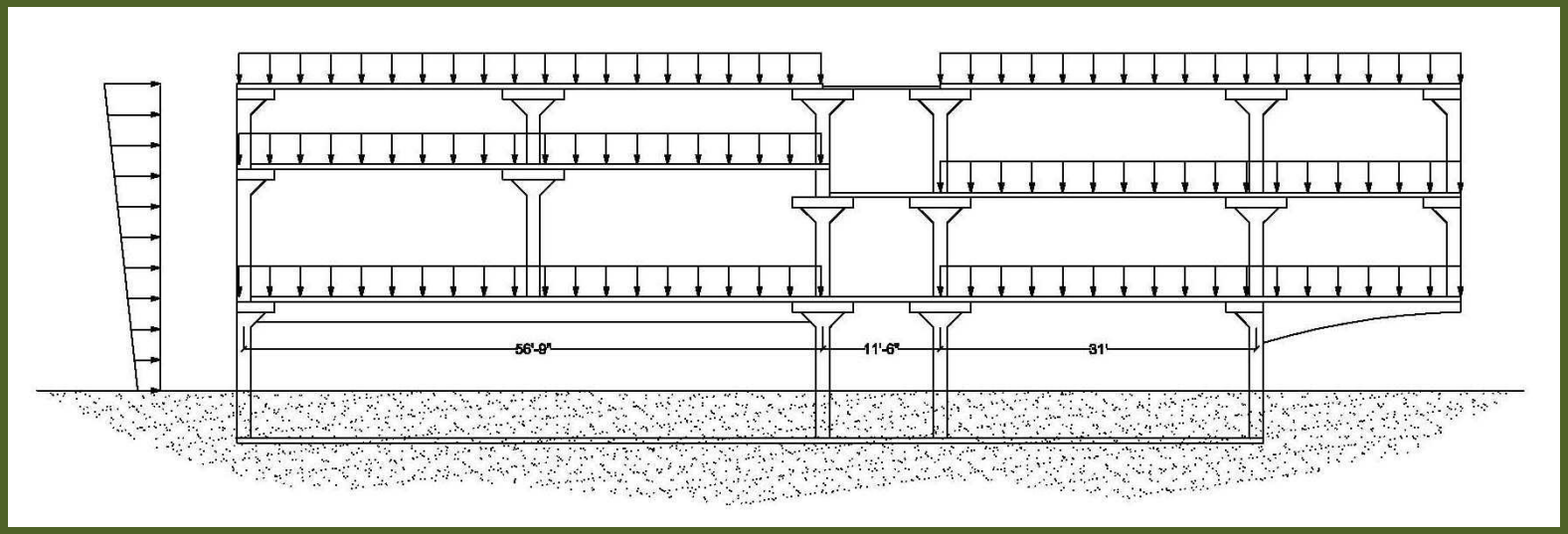
Green Box

Shear Walls

Structural Elevation

East Elevation





Section Through the Auditorium

Green Box Detail

Green Box Structure Profile:

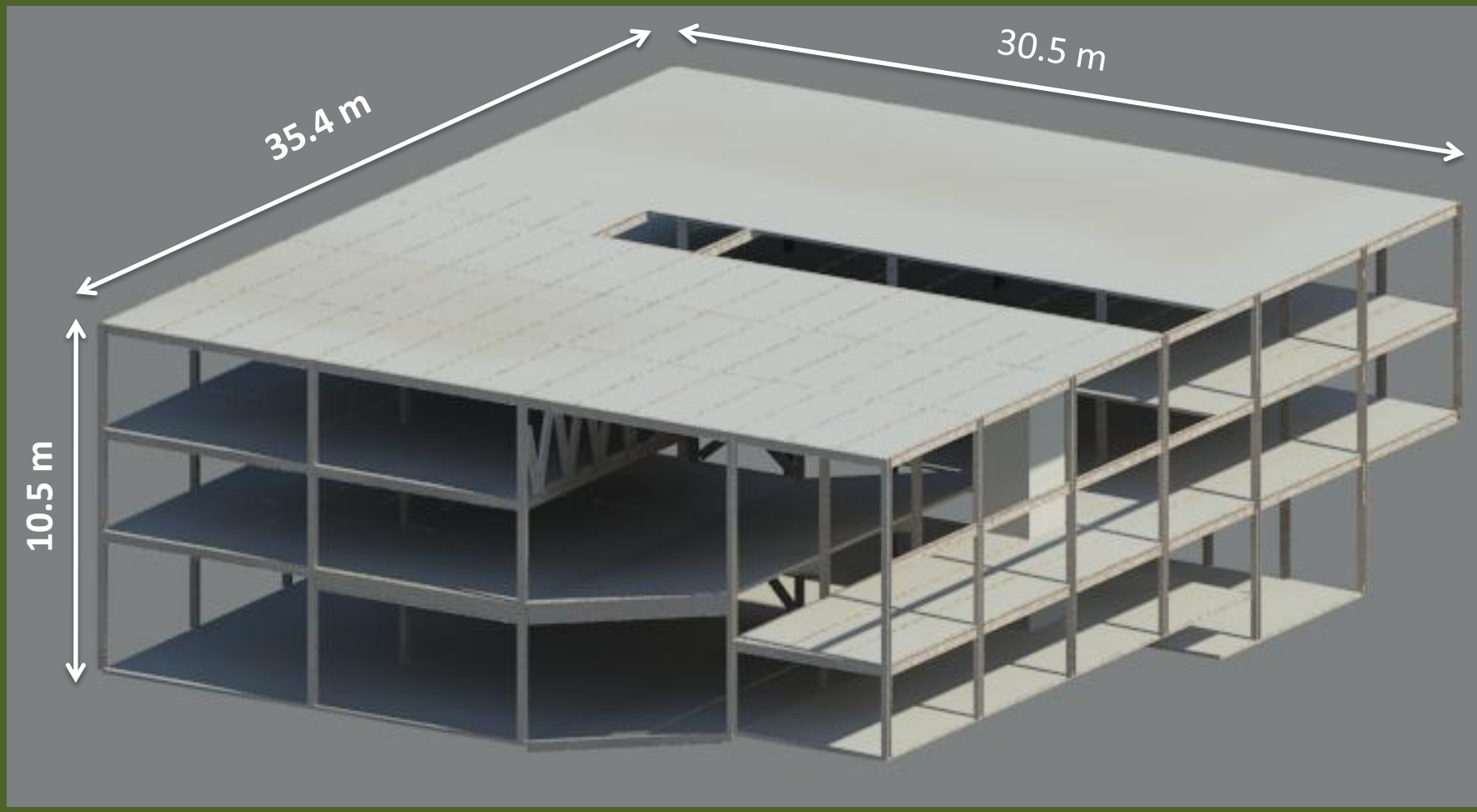
- Columns with capitals and drop panels
- 8” two way flat slab with beams
- 4 shear walls

Periphery Detail

Periphery Structure Profile:

- Columns with capitals and drop panels
- 6” two way flat slab
- 5 shear walls
- Arched beams supporting the cantilever

Green Box- Steel

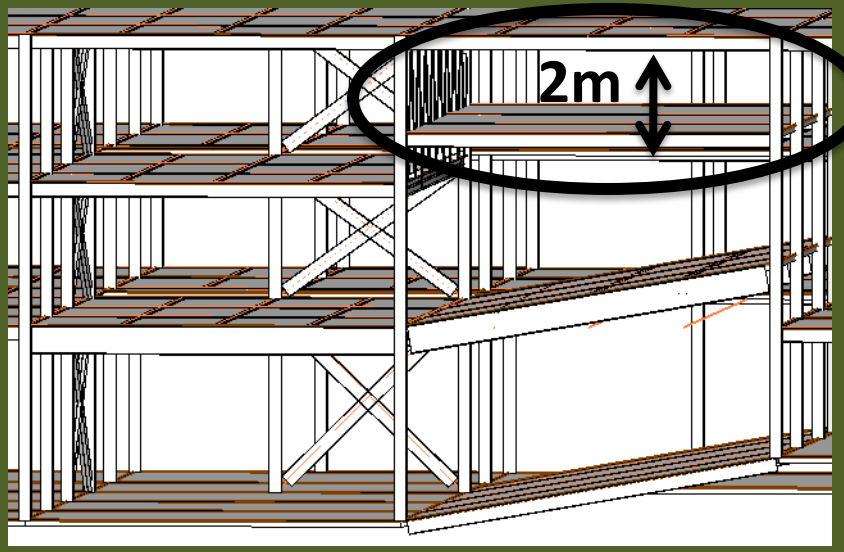


Solutions- Auditorium

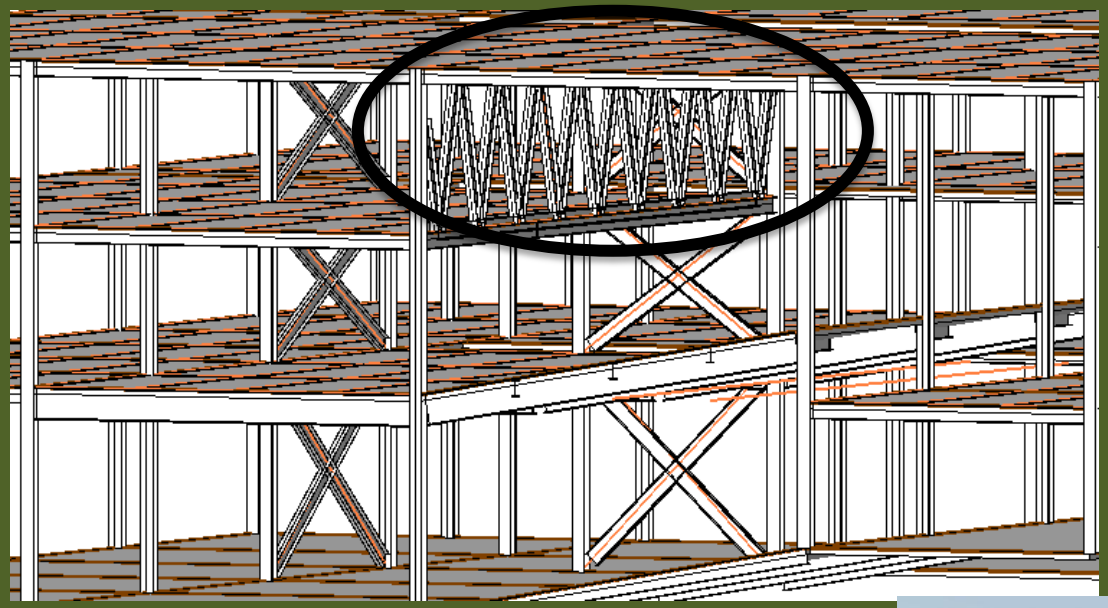
Need to reduce loading on top of the auditorium.

Solution 1-
-Remove wasted floor space
-Removes 2 columns and allows for solution 2

Solution 2-
-Truss to carry more load
-Spans 17.3 m



REMOVED



SAP Analysis

W 24 x 104

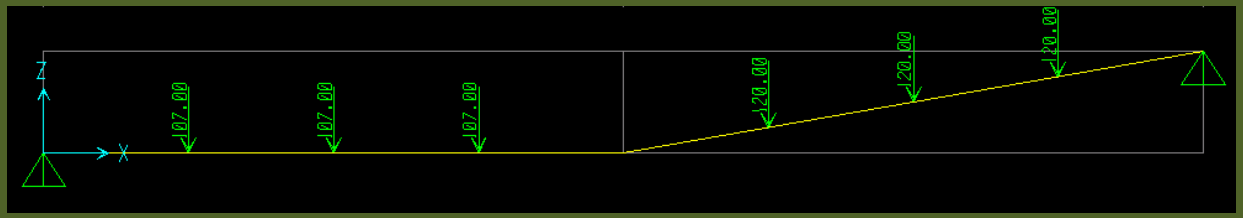
Girder loading
P= 107 kN
P=120 kN

Girder Moment
Mu = 528 kN-m

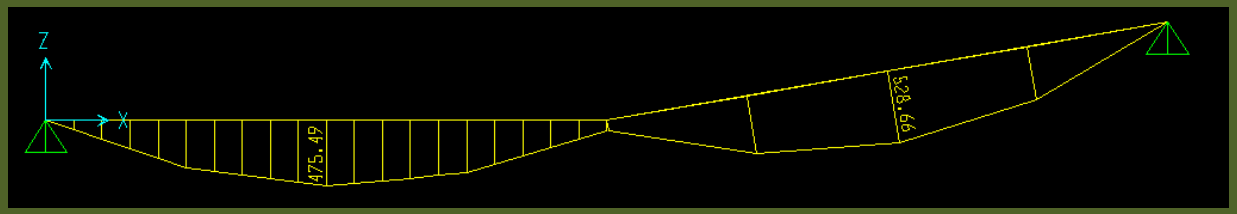
Girder Shear
V=186 kN

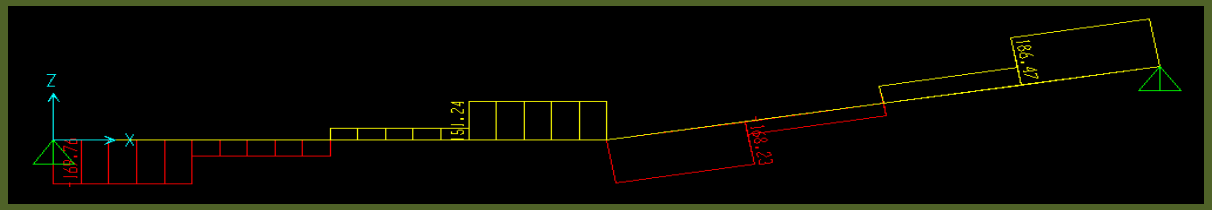
Max Deflection:

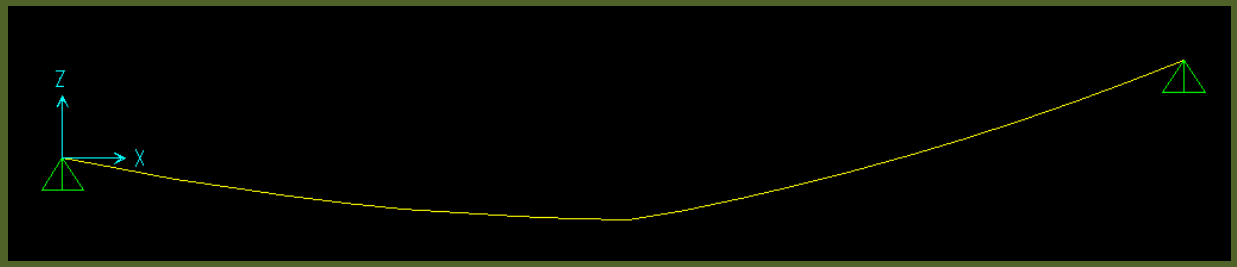
= .0043 m (1.7”)



16.3 m





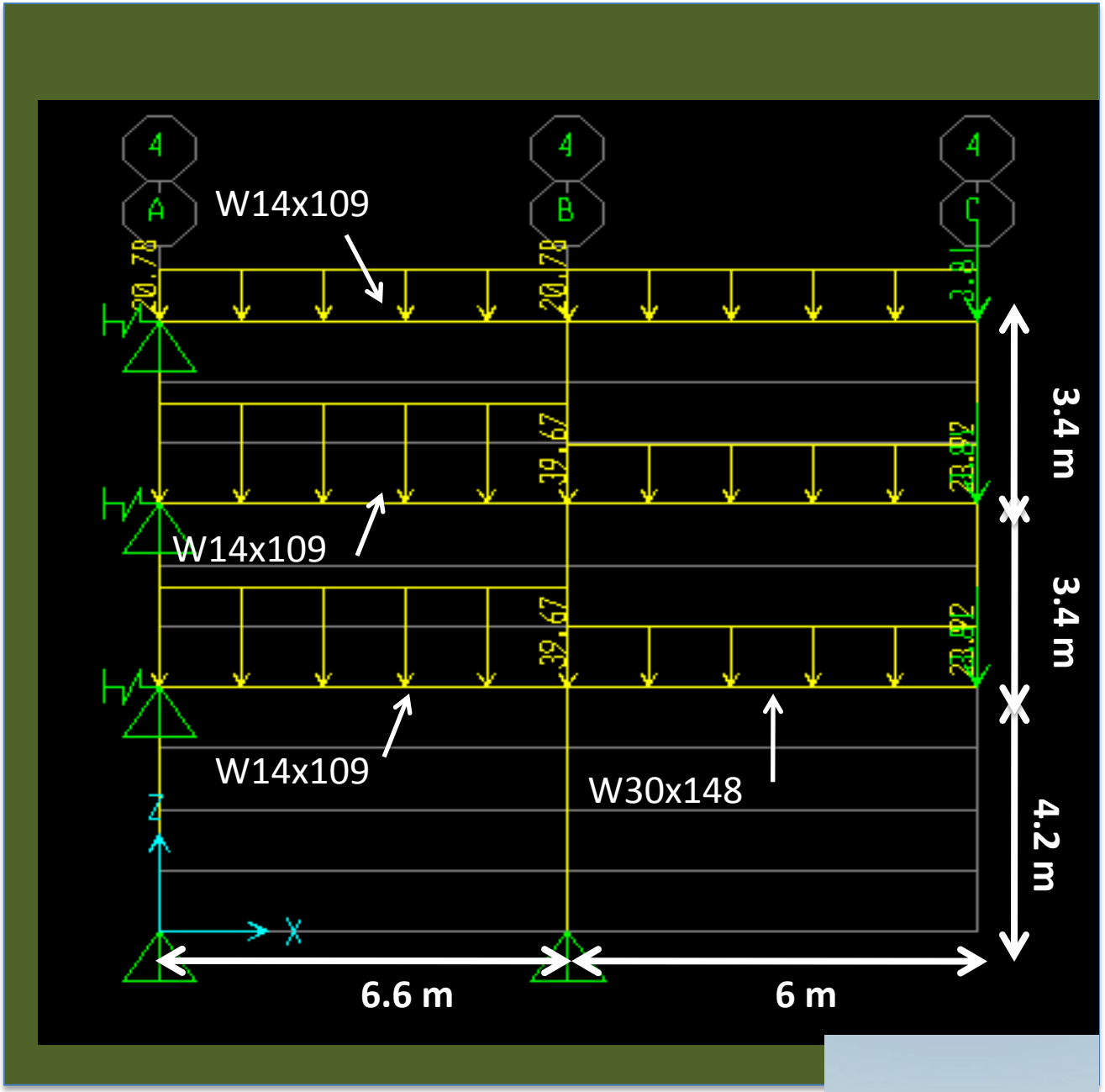


Solutions- Cantilever

-Large girders.

-Increase beam size on third floor and roof

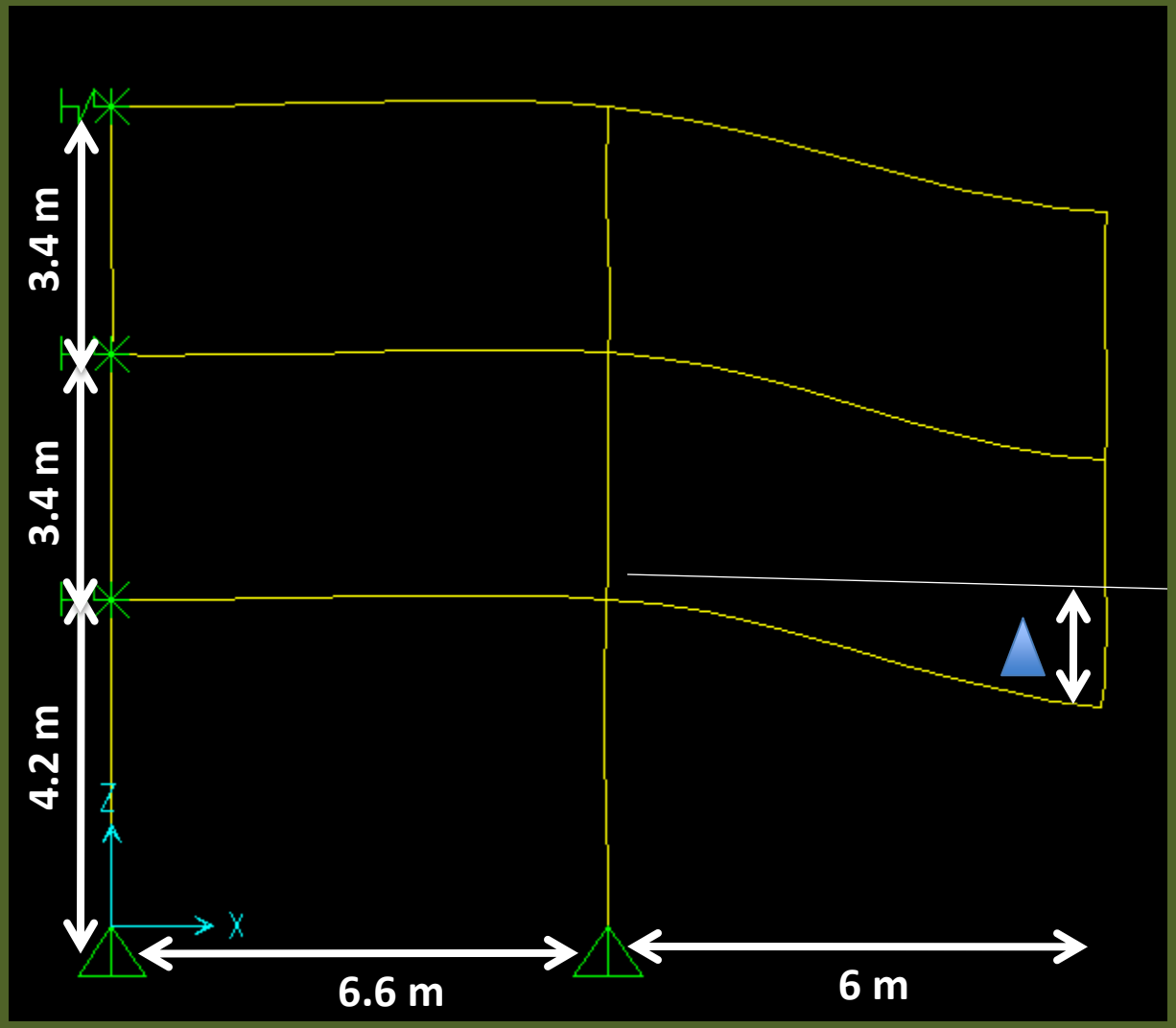
-Add extra columns to reduce Tributary Area



SAP Analysis

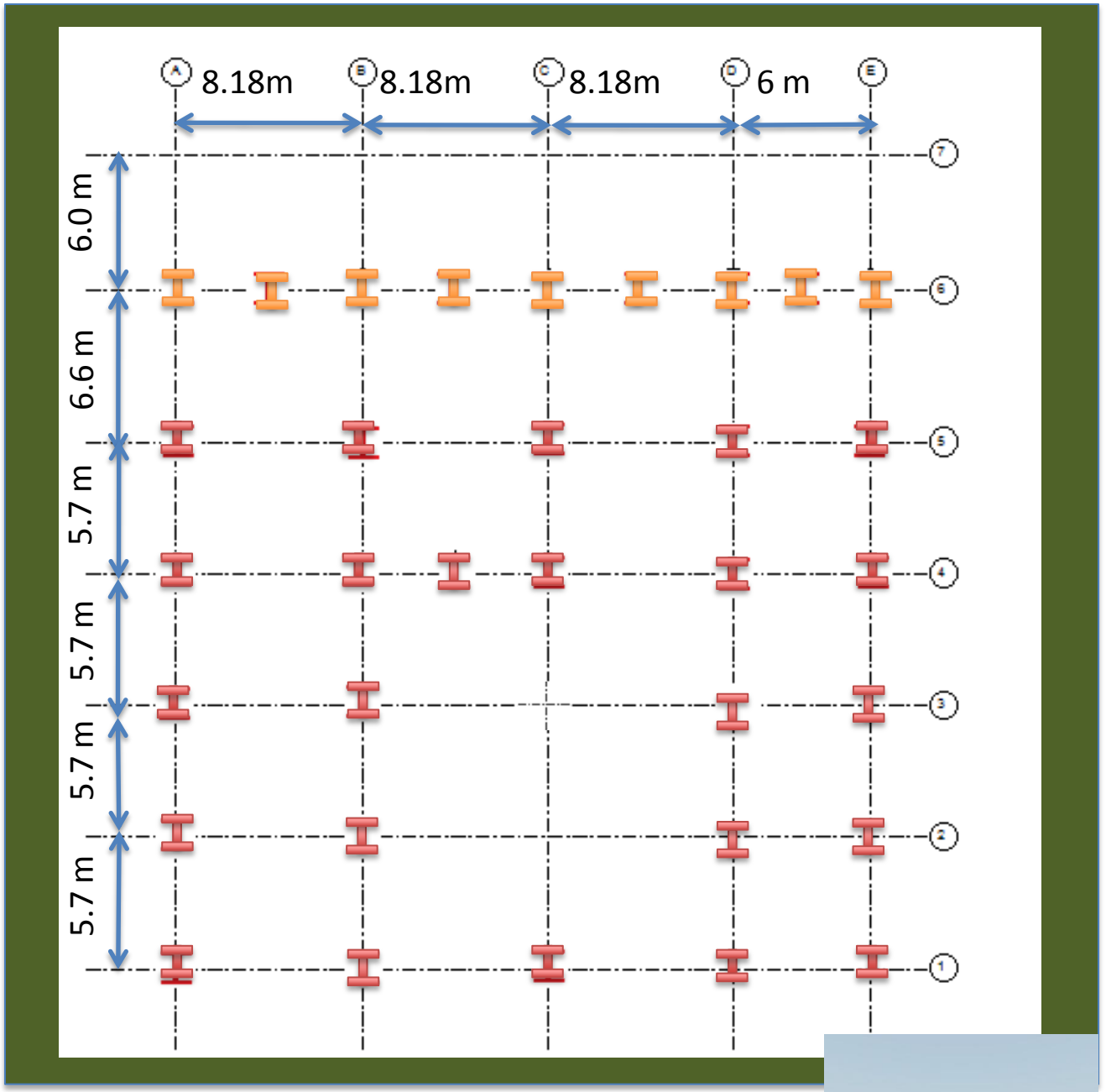
Deflection

=.015 m (.59”)



Level 1 Floor Plan

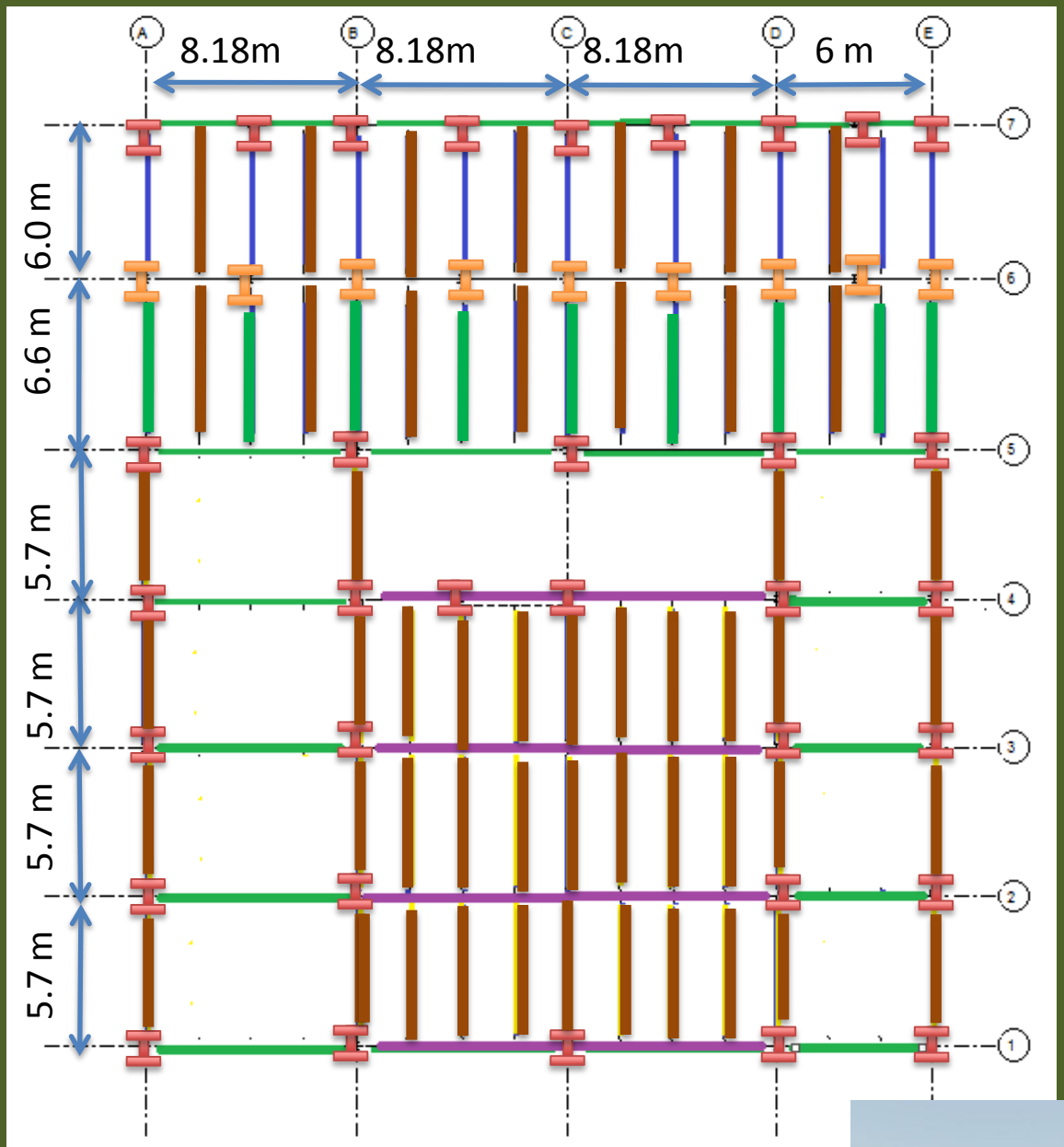
Columns
W 10 x 33
W12 x 40



Level 2 Floor Plan

- W14 x 109
- W12 x 35
- W24 x 104
- W30 x 148

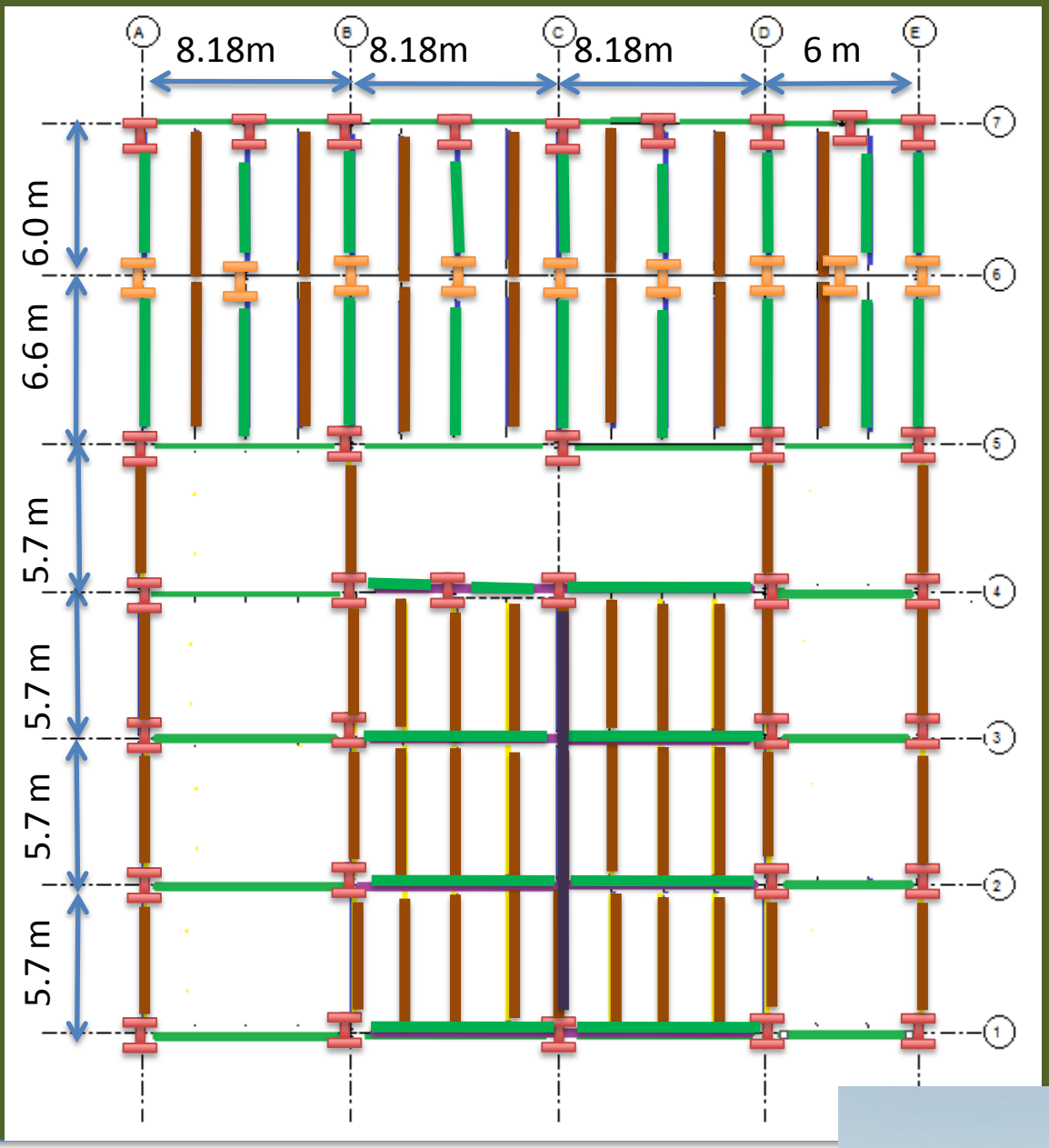
Columns
W 10 x 33
W 12 x 40



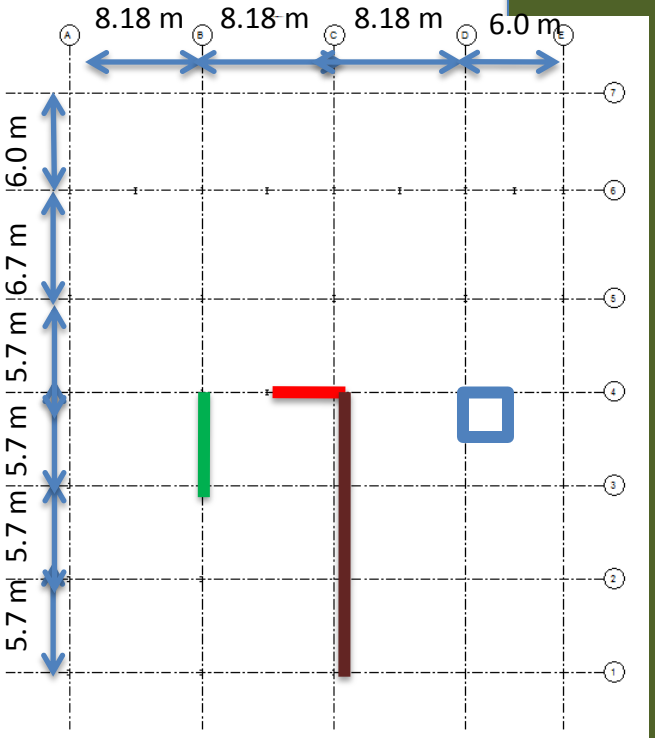
Level 3 Floor Plan

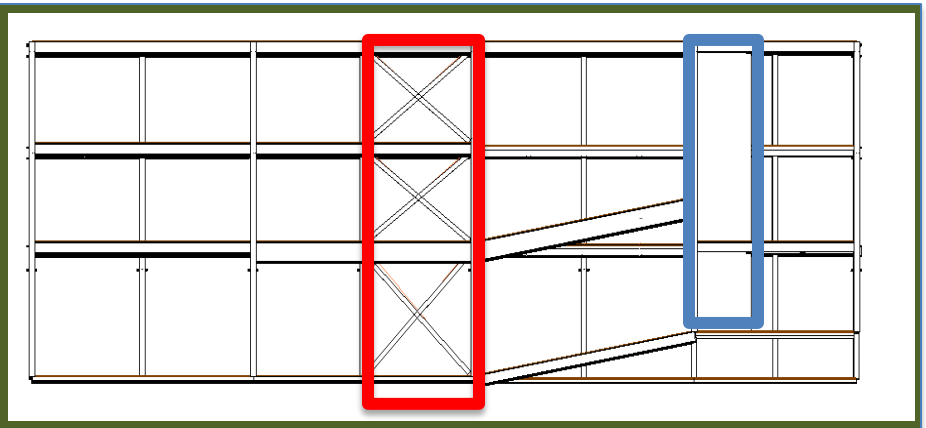
- W14 x 109
- W12 x 35
- Truss

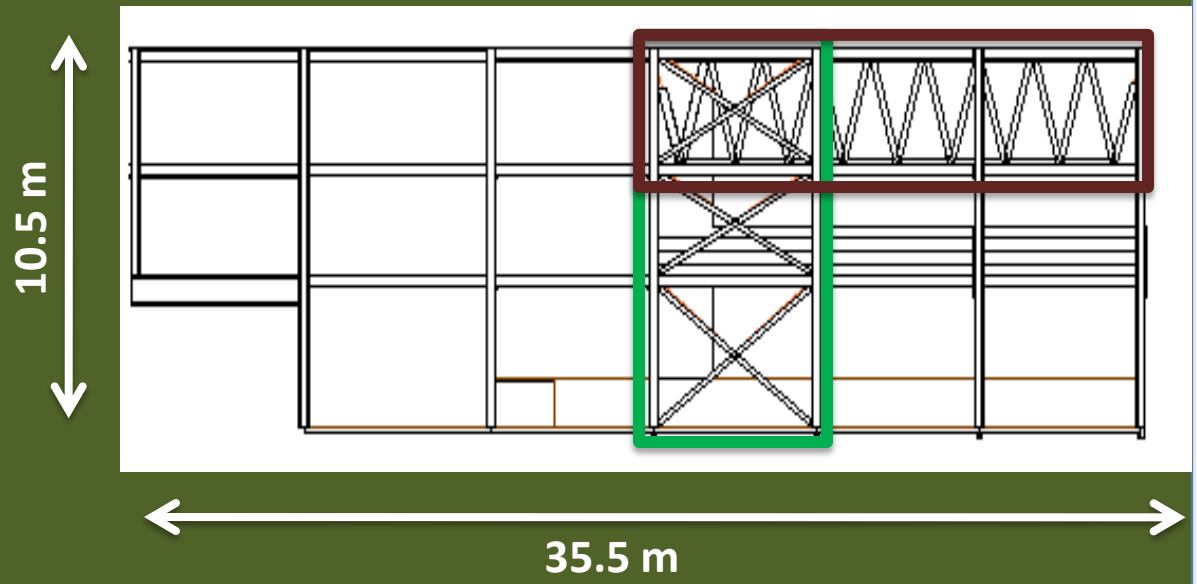
Columns
W 10 x 33
W 12 x 40



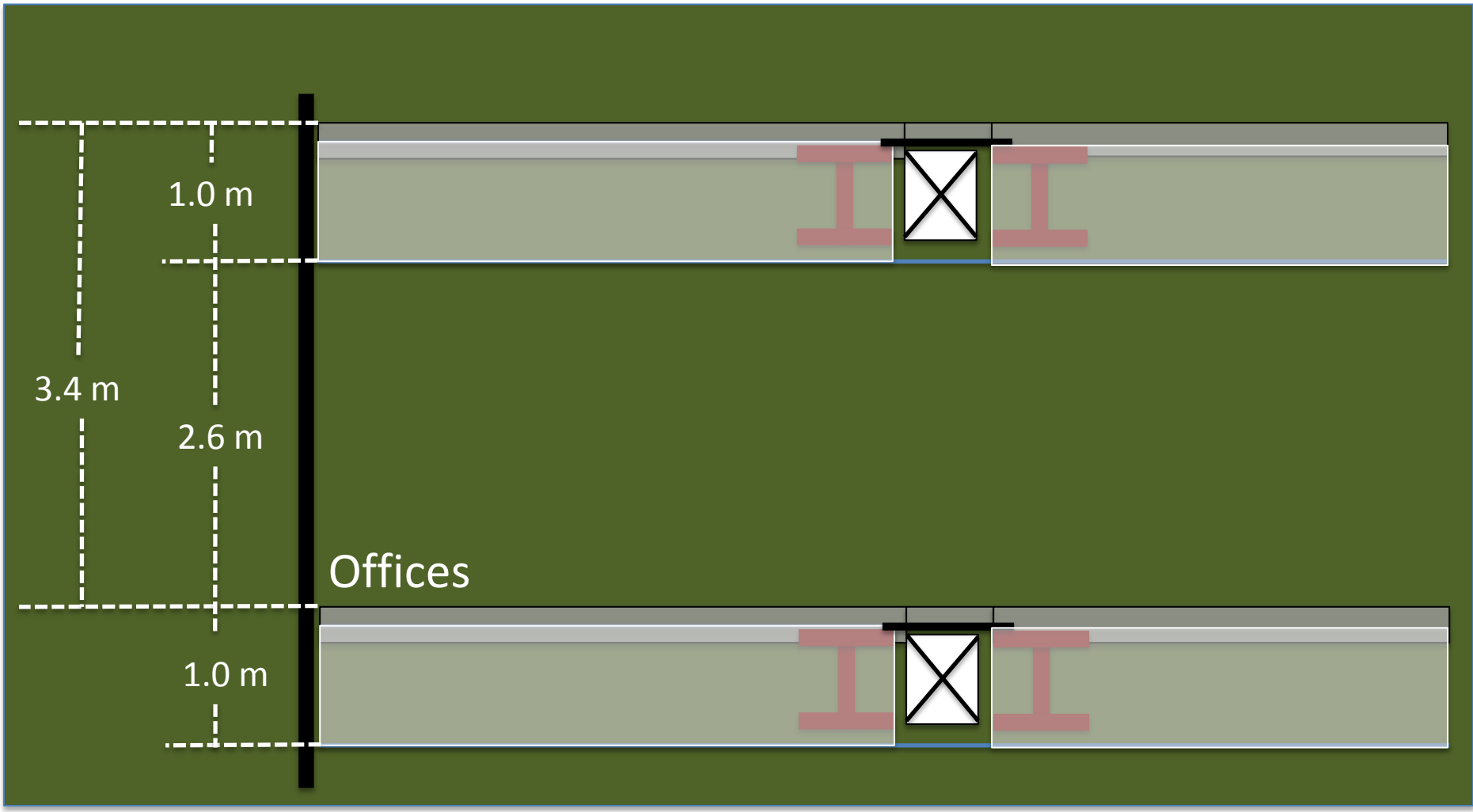
Lateral Sub-Syst



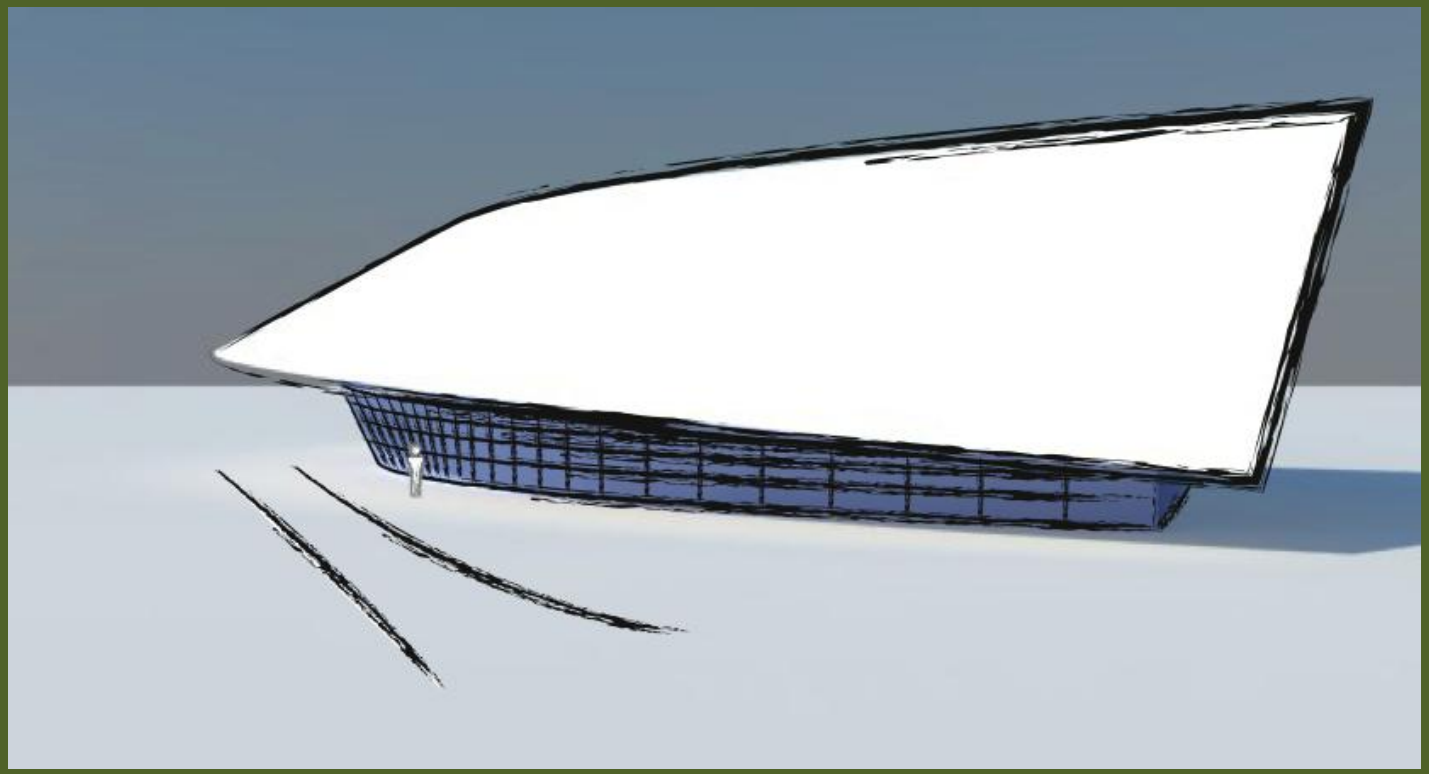




Floor to Floor Height

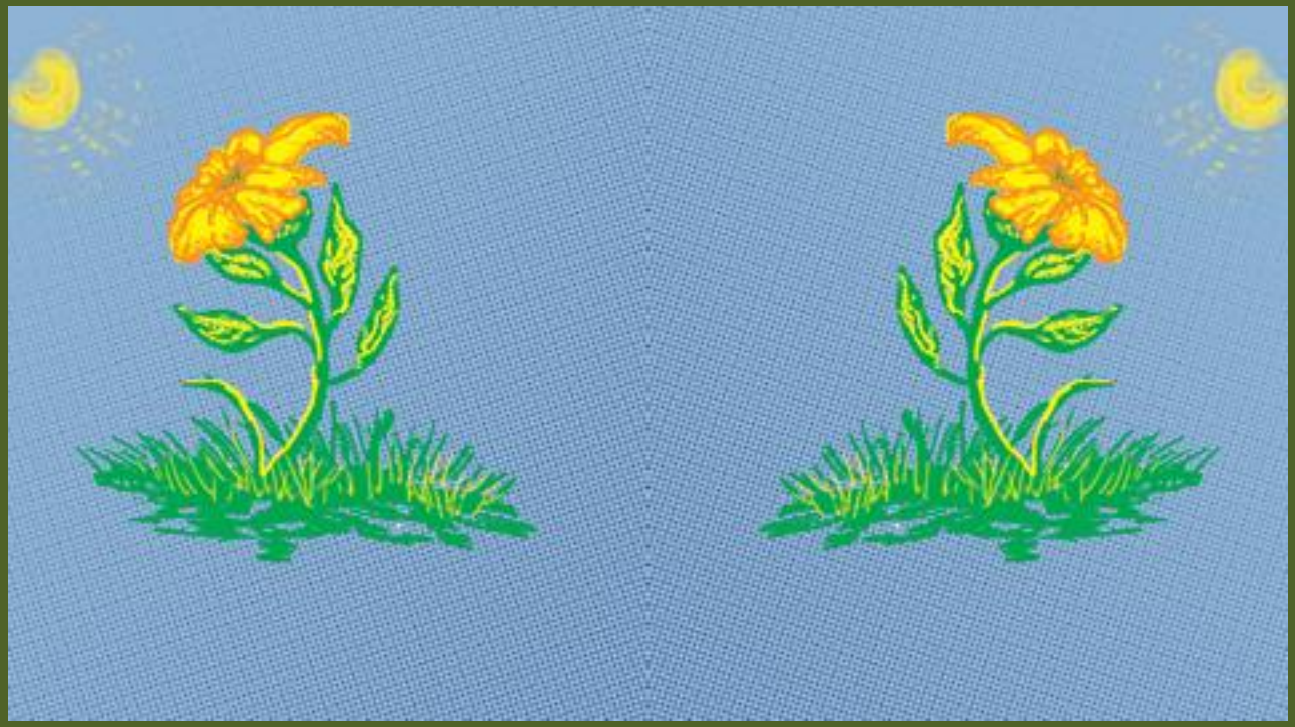


Helio



Bio Mimicry

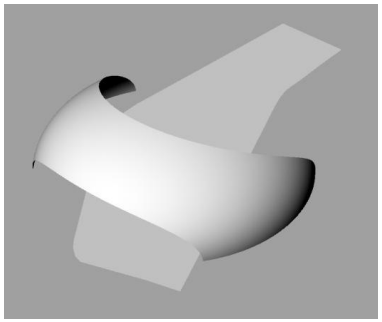
Heliotropism is the diurnal motion of plant parts (flowers or leaves) in response to the direction of the sun



Big idea

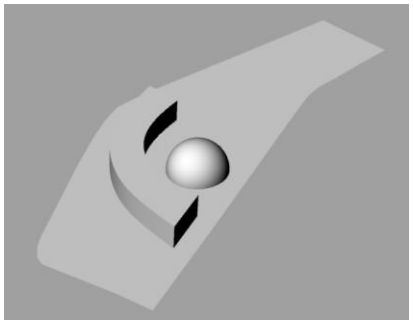
It all started with an idea

Sun Path on site



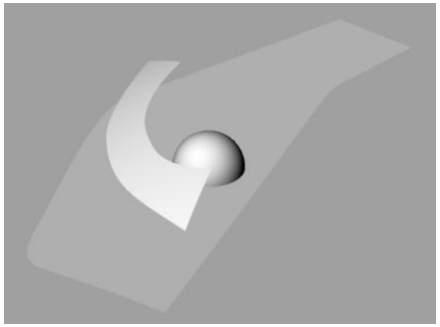
Subtract

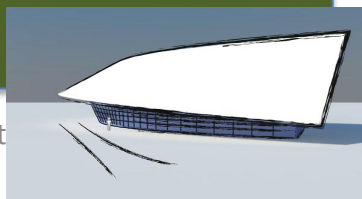
Embrace space



Equals

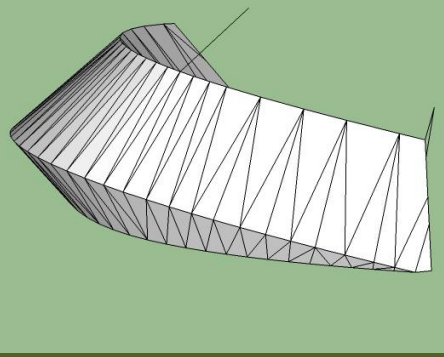
Roof shape

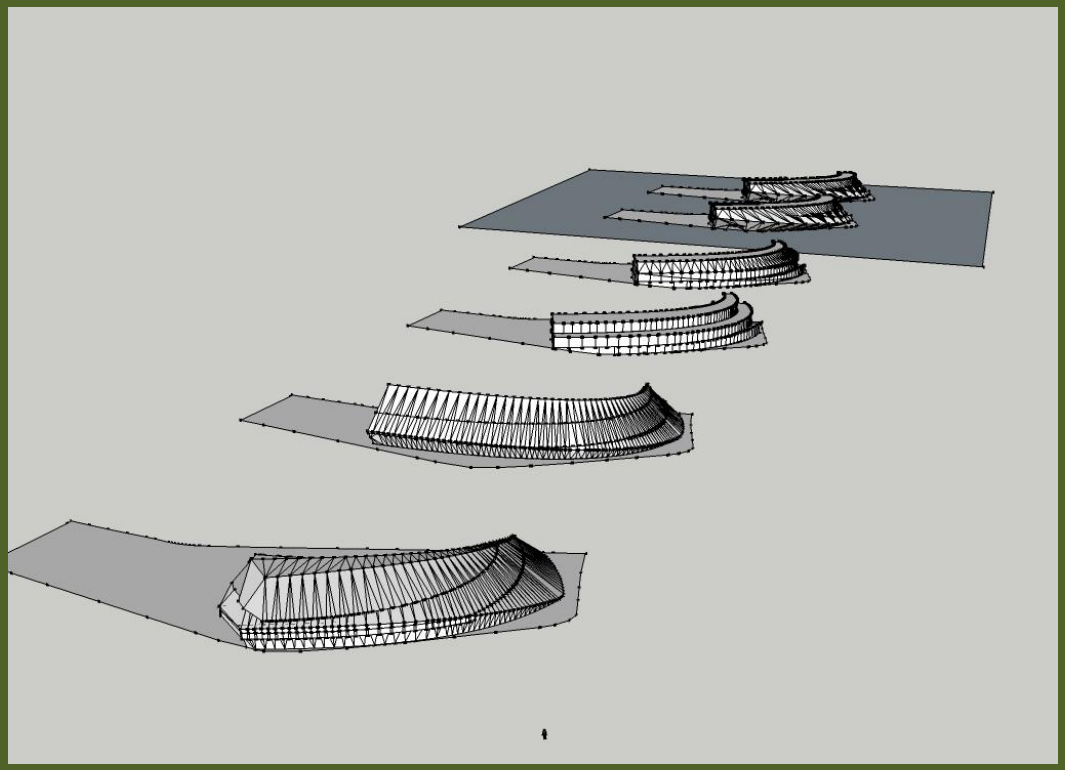


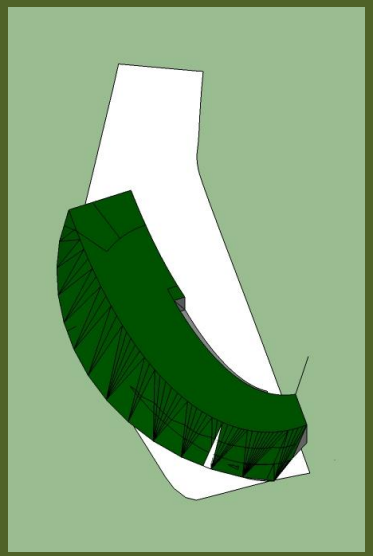


Iterations

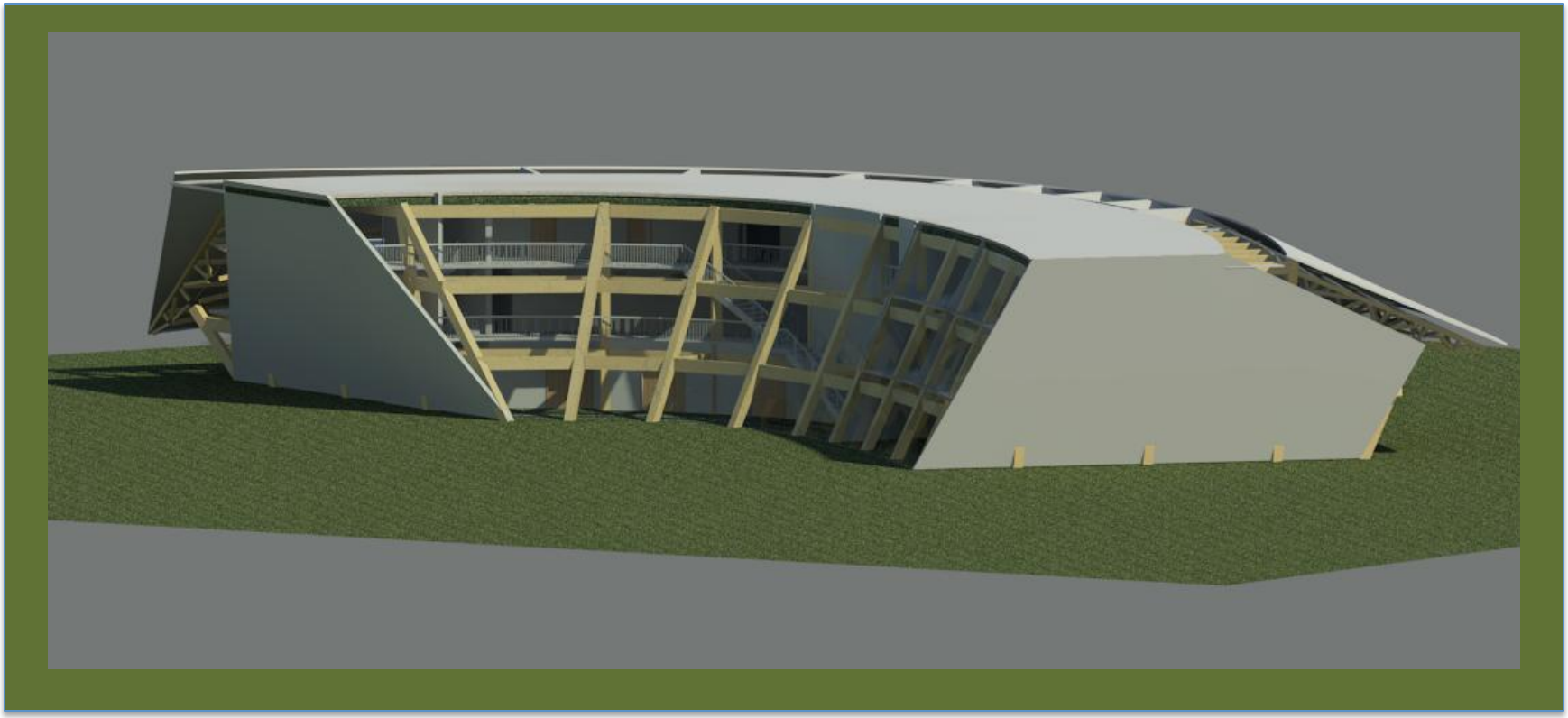
Evolution of the design

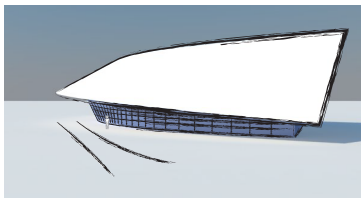




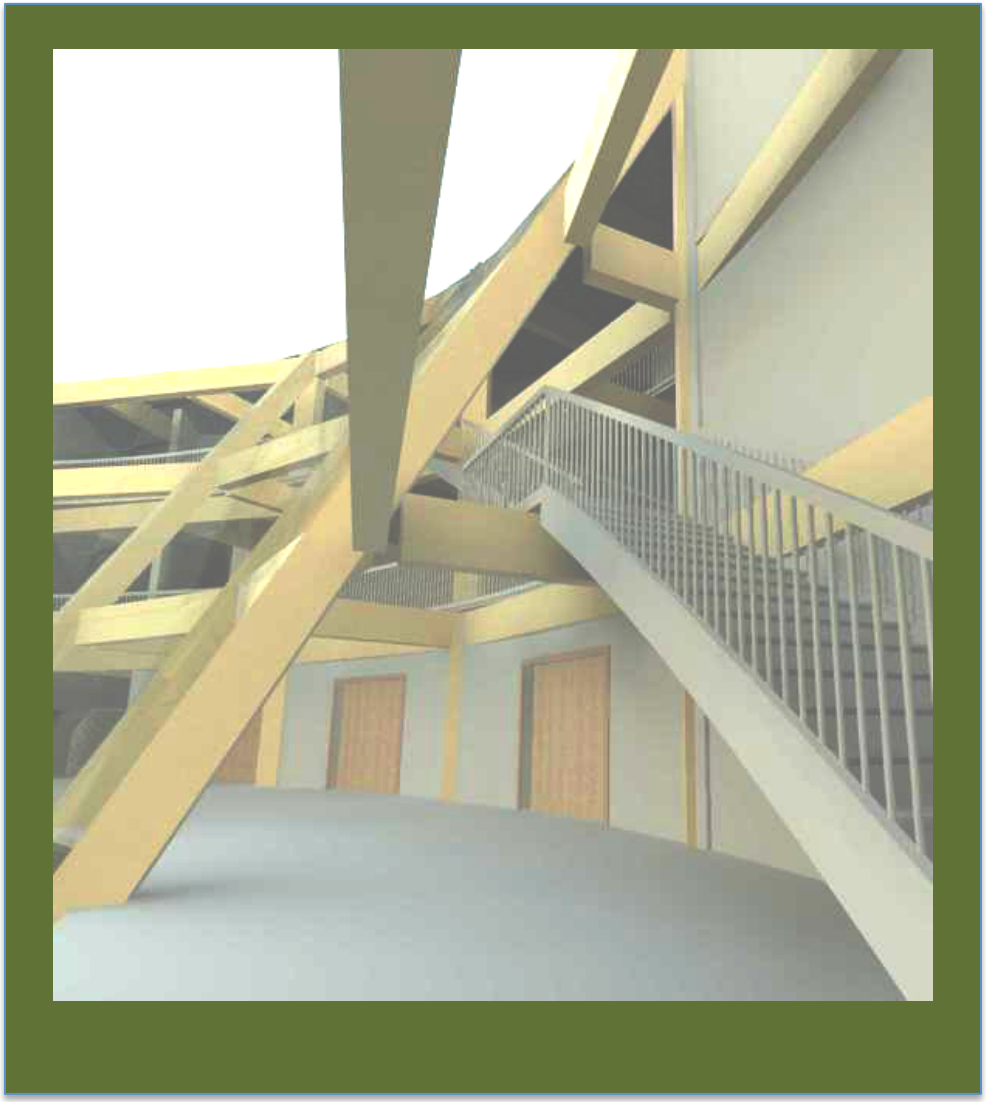


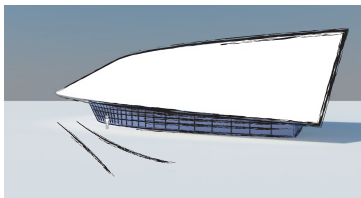
3d Overview





Atrium



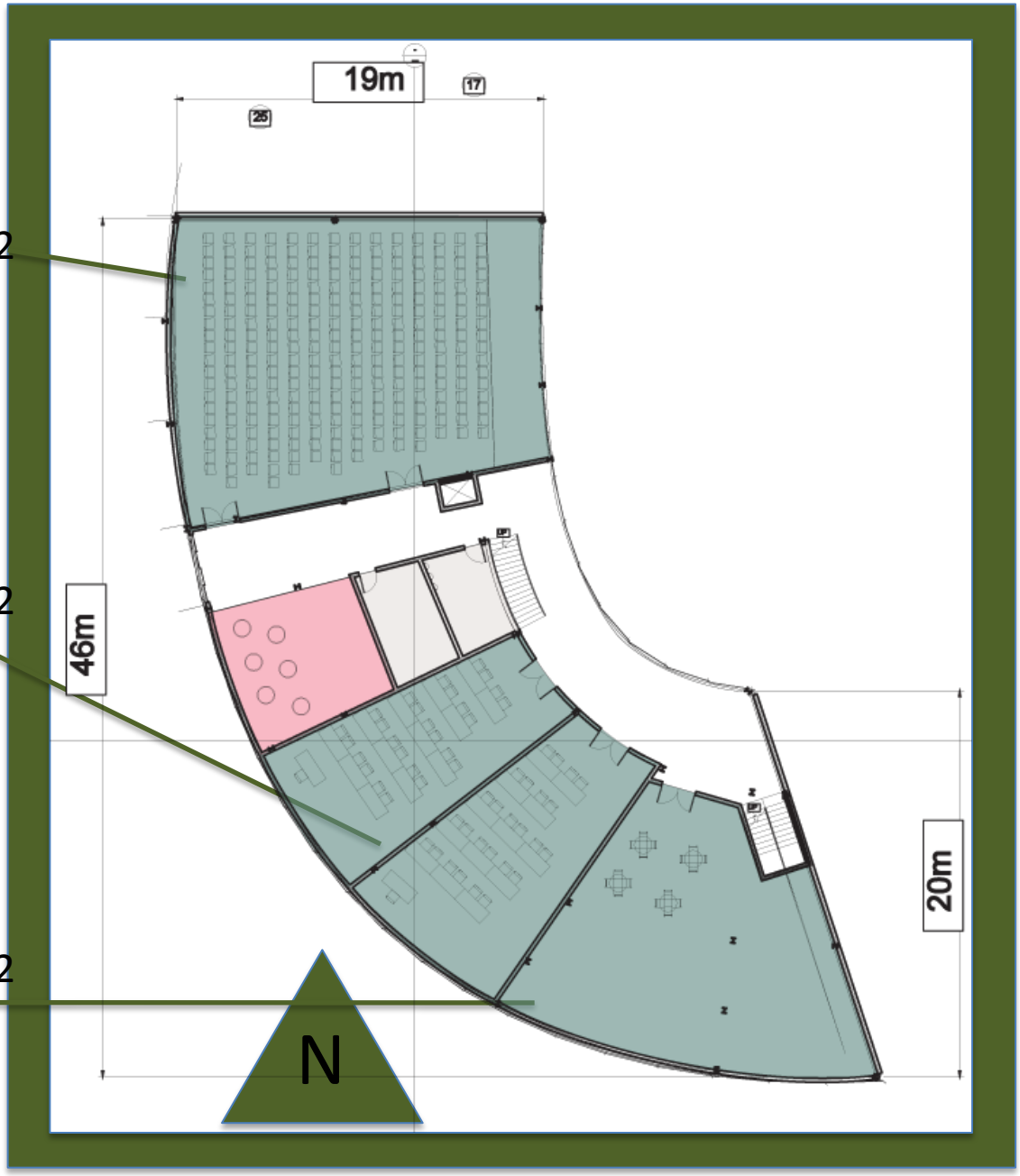


1st floor

Auditorium 280m2

Instructional labs 184m2

Student offices 125m2



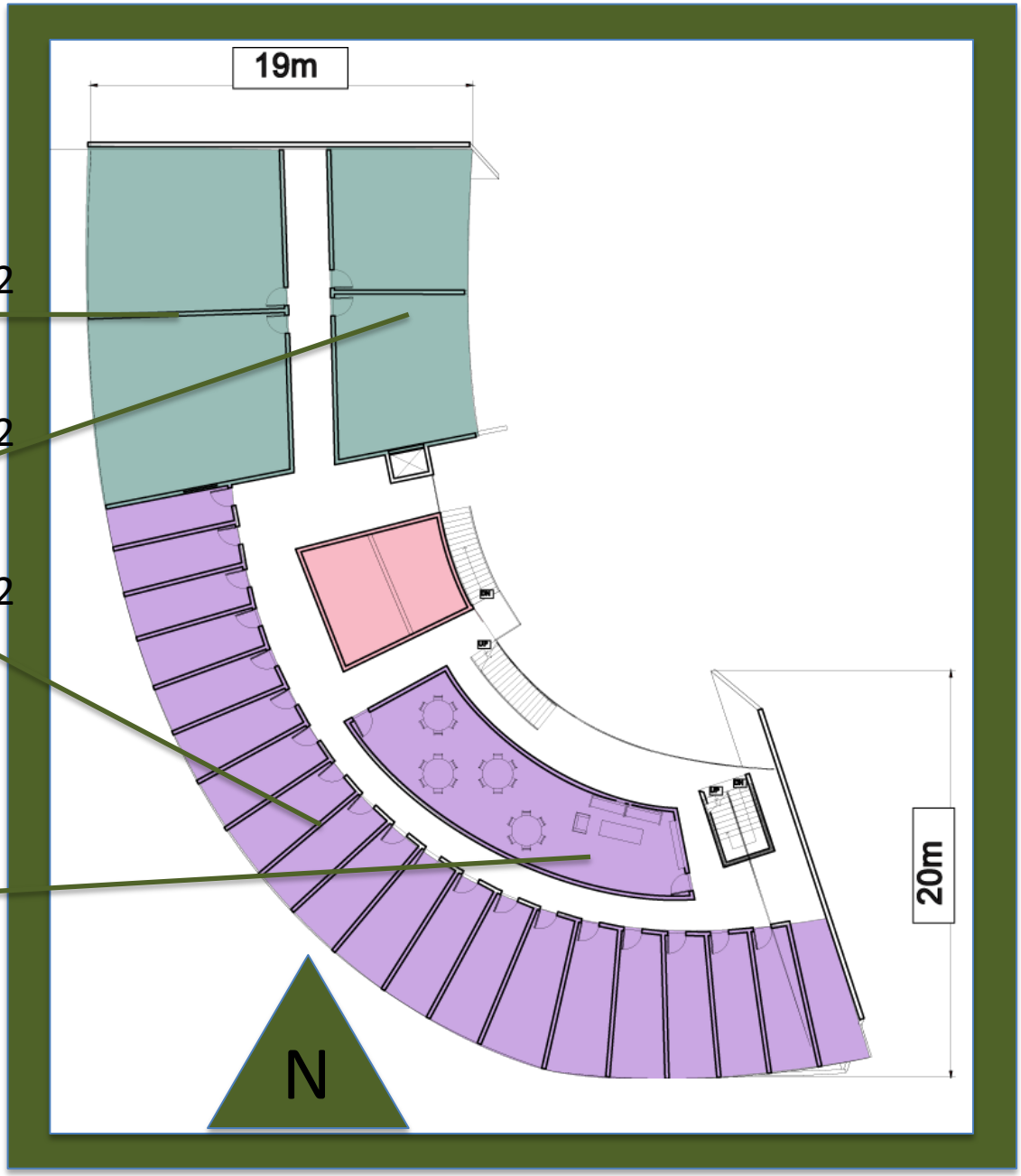
2nd floor

Large Classrooms 150m2

Small Classrooms 180m2

Faculty offices 321m2

Faculty lounge 66m2



3rd floor

Classrooms

Small Classrooms 180m2

Seminar room 75m2

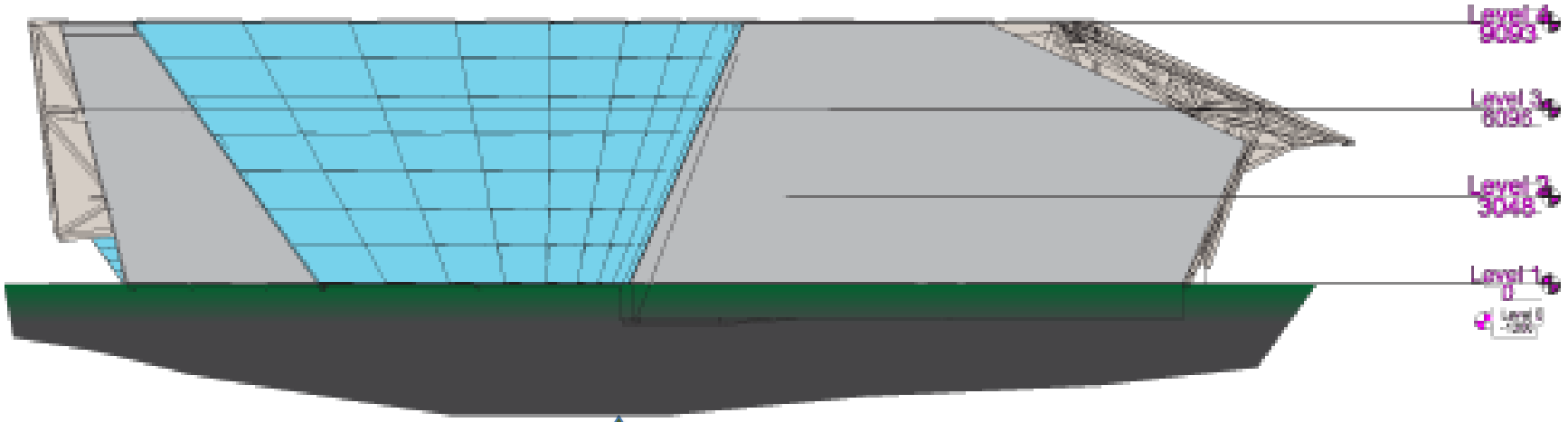
Administration 90m2

MEP room 65m2

Storage 95m2

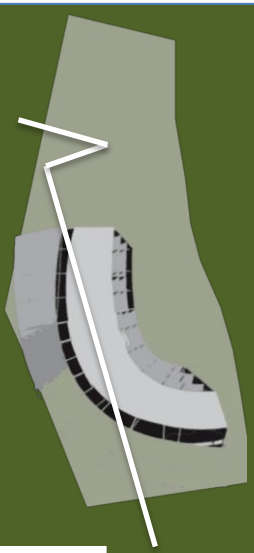
North Facade

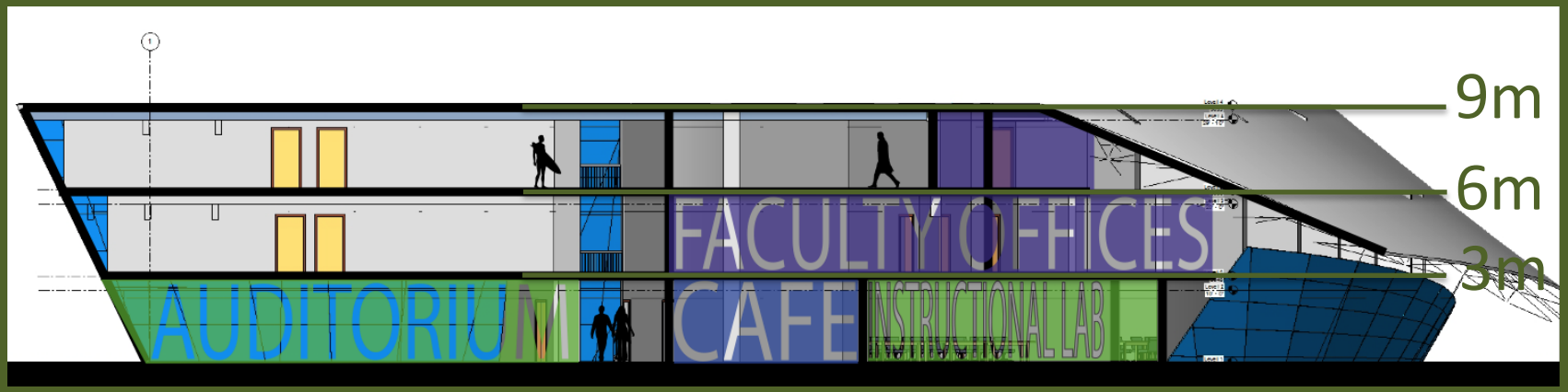
Classrooms

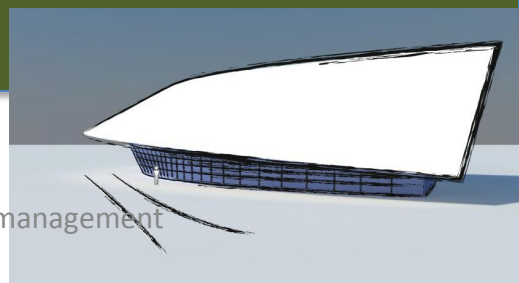


N

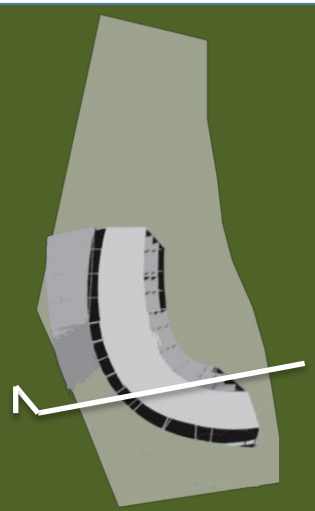
Section A



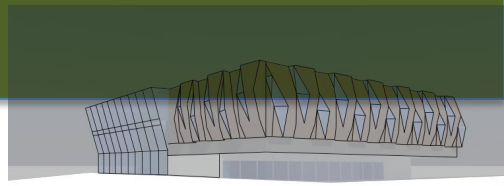

9m
6m
3m
AUDITORIUM
CAFE
FACULTY OFFICES
INSTRUCTIONAL LAB



Section B



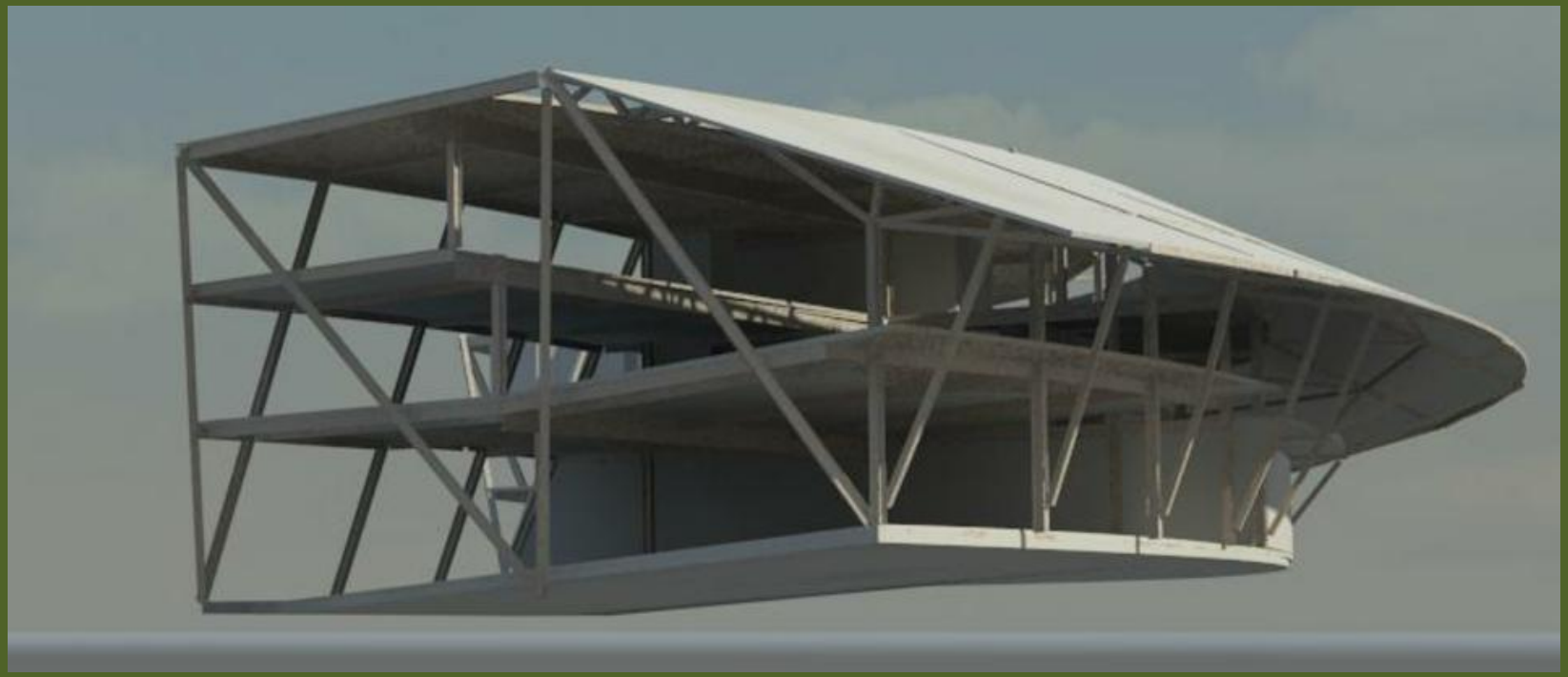

9m
6m
3m
MEP
FACULTY OFFICES
FACULTY LOUNGE
STUDENT OFFICES
STAIRS



Heliotropism – Structural

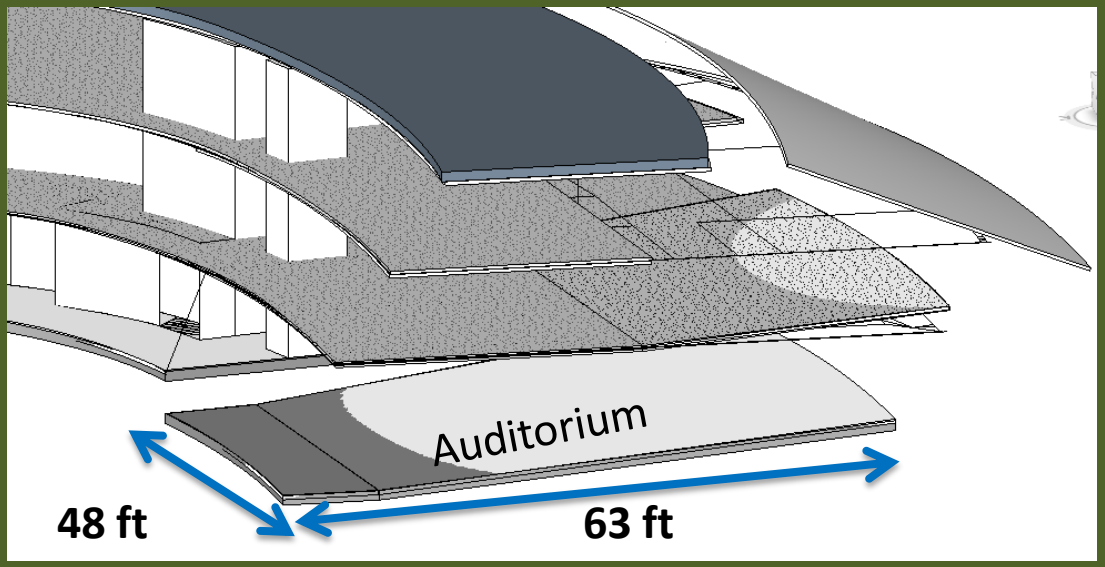
Structural Options:

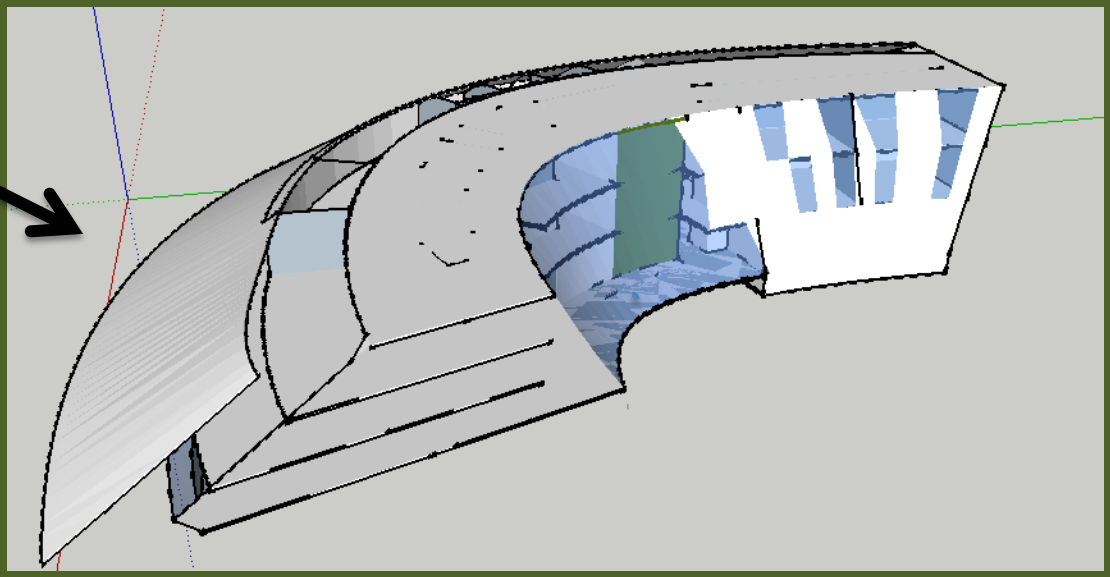
- **Steel**
- **Timber**



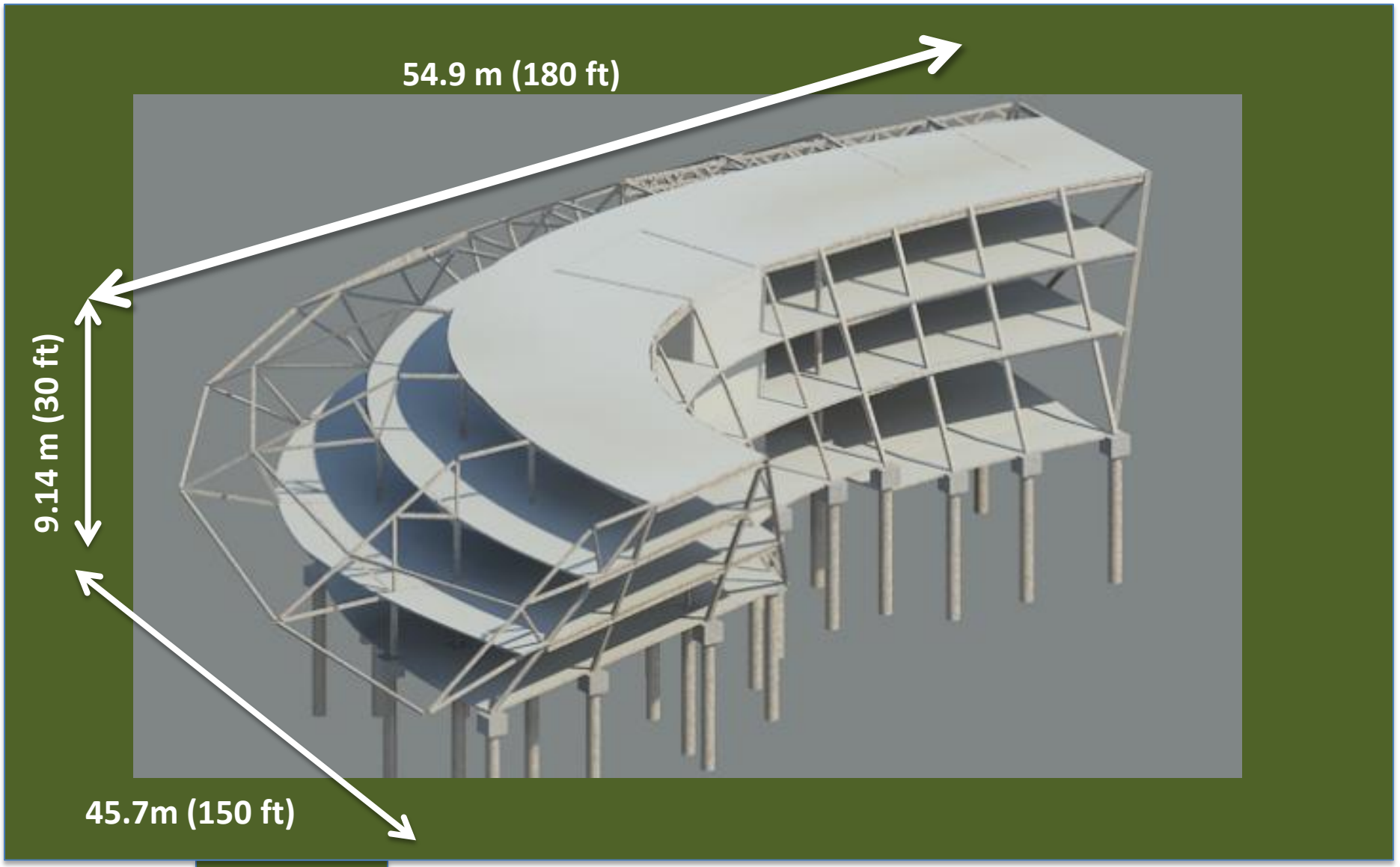
Design Challenges

- 1st Floor Auditorium spans
- Curved, cantilevered green roof
- Slanted profile





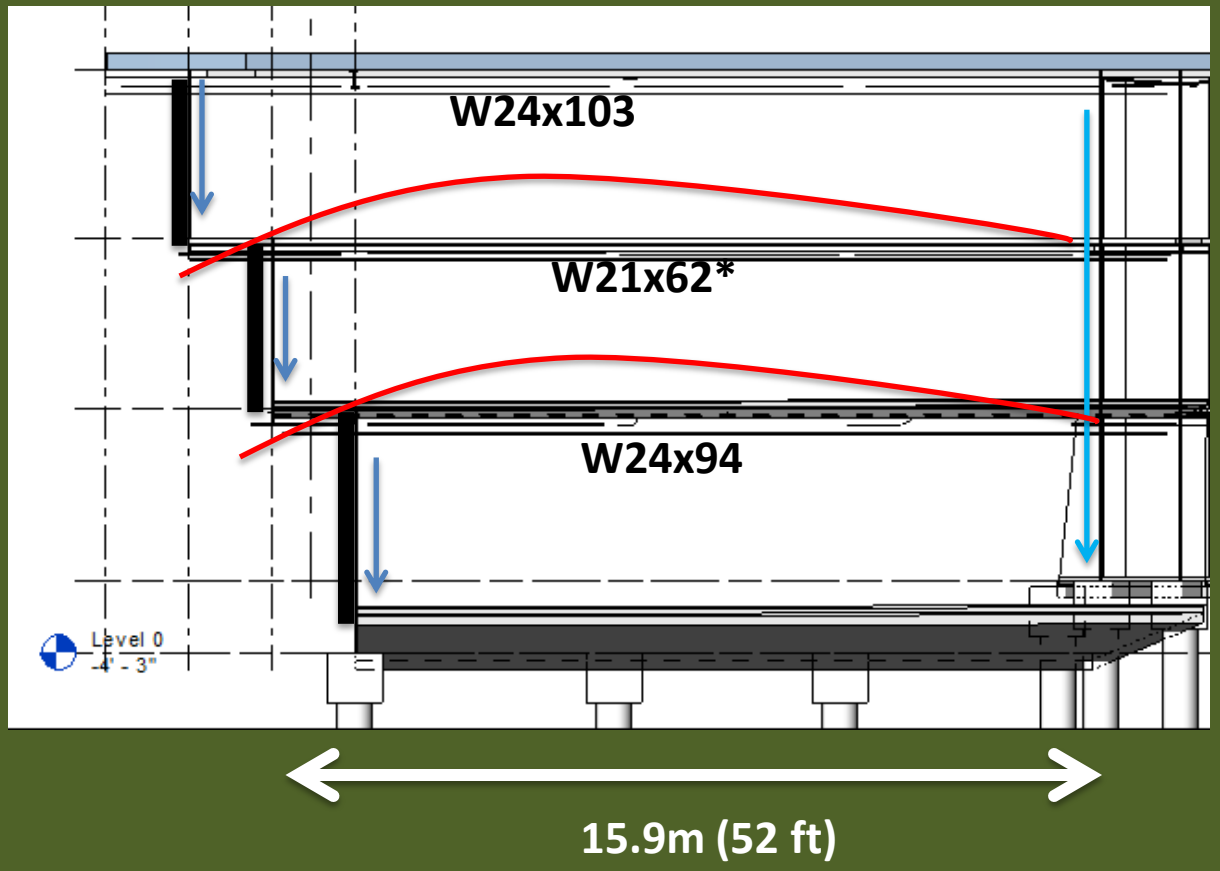
Heliotropism – Steel Structure



Solutions

- Auditorium spans
- Curved, cantilevered roof
- Slanted profile

Use shape to advantage with stepped columns



*3rd Floor spans ½ the length of the auditorium

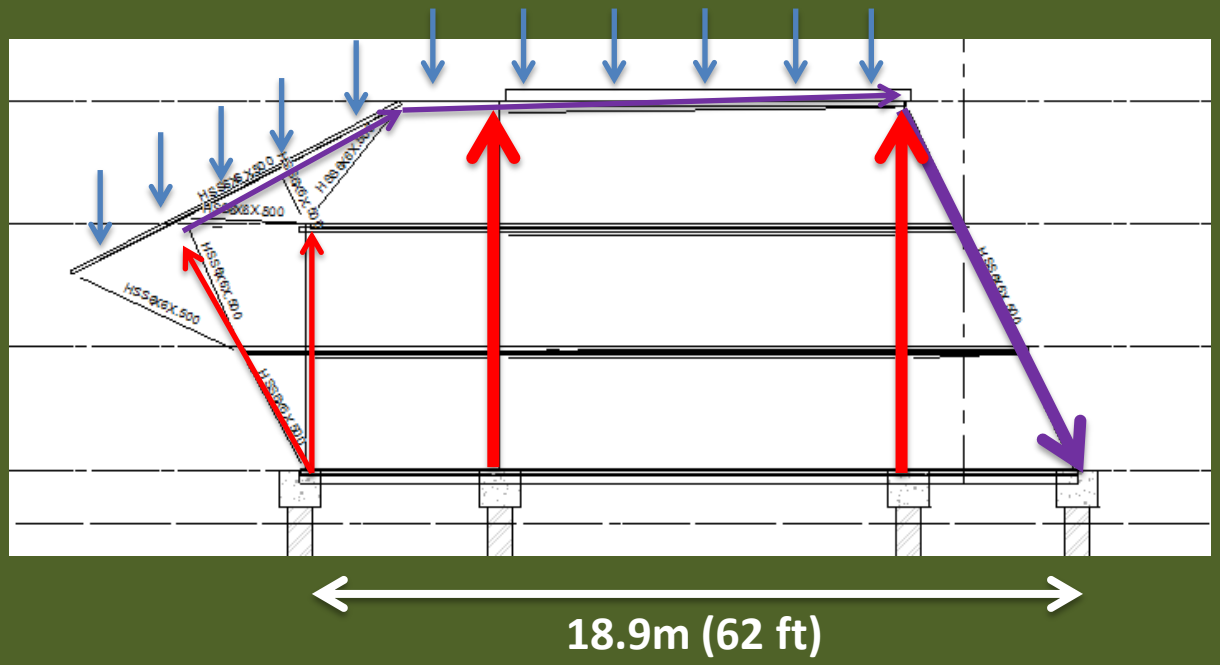
Solutions

- Auditorium spans

- Curved, cantilevered roof

- Slanted profile

- Cut building into radial sections
- Use slanted shape for lateral stiffness



Gravity and Lateral System

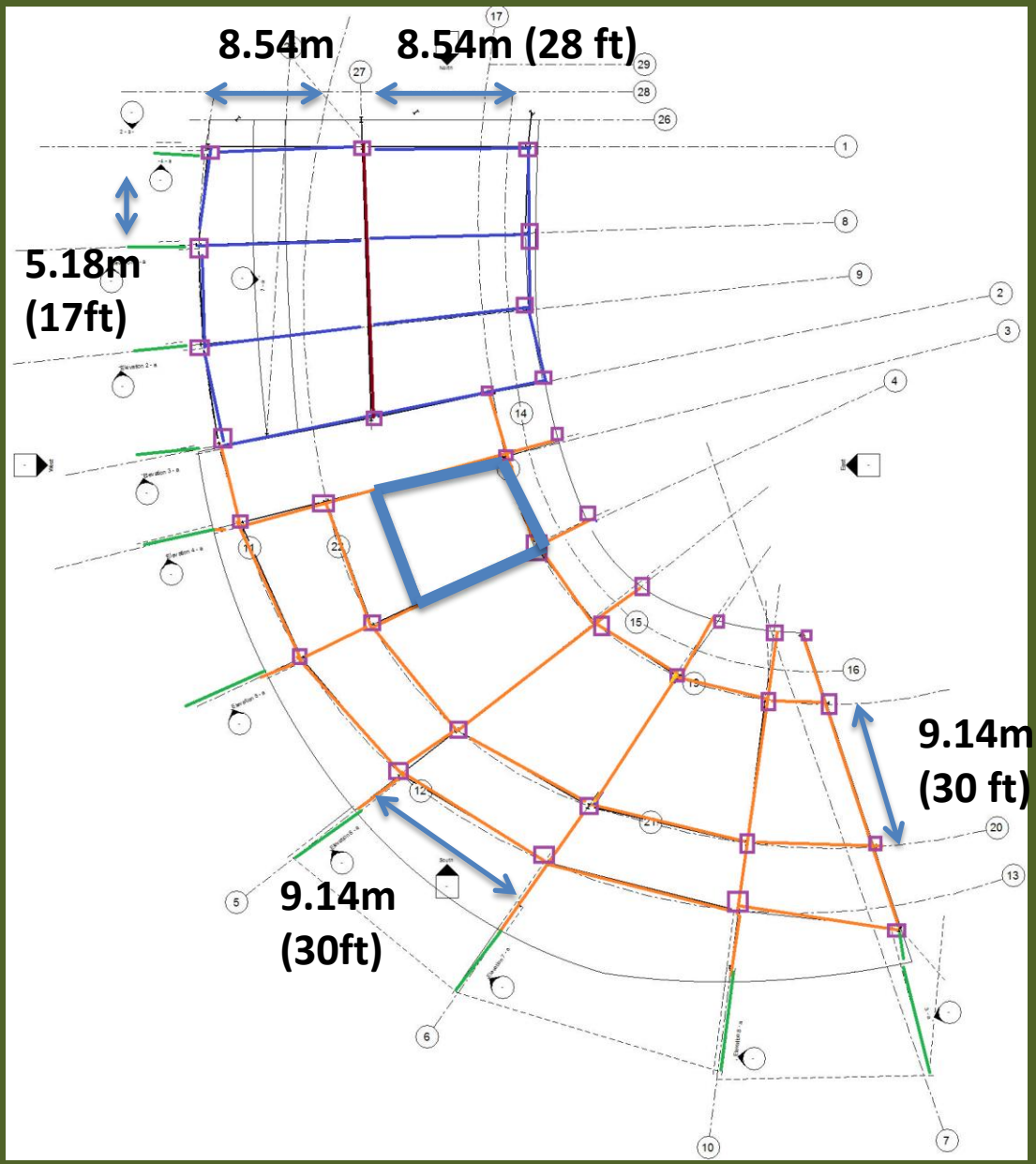
Beams
- W24x94
- W12x35
- W12x50

Columns
- W10x33

Roof Truss
- HSS6x6x0.5

Braced Frame

RC Shear Wall



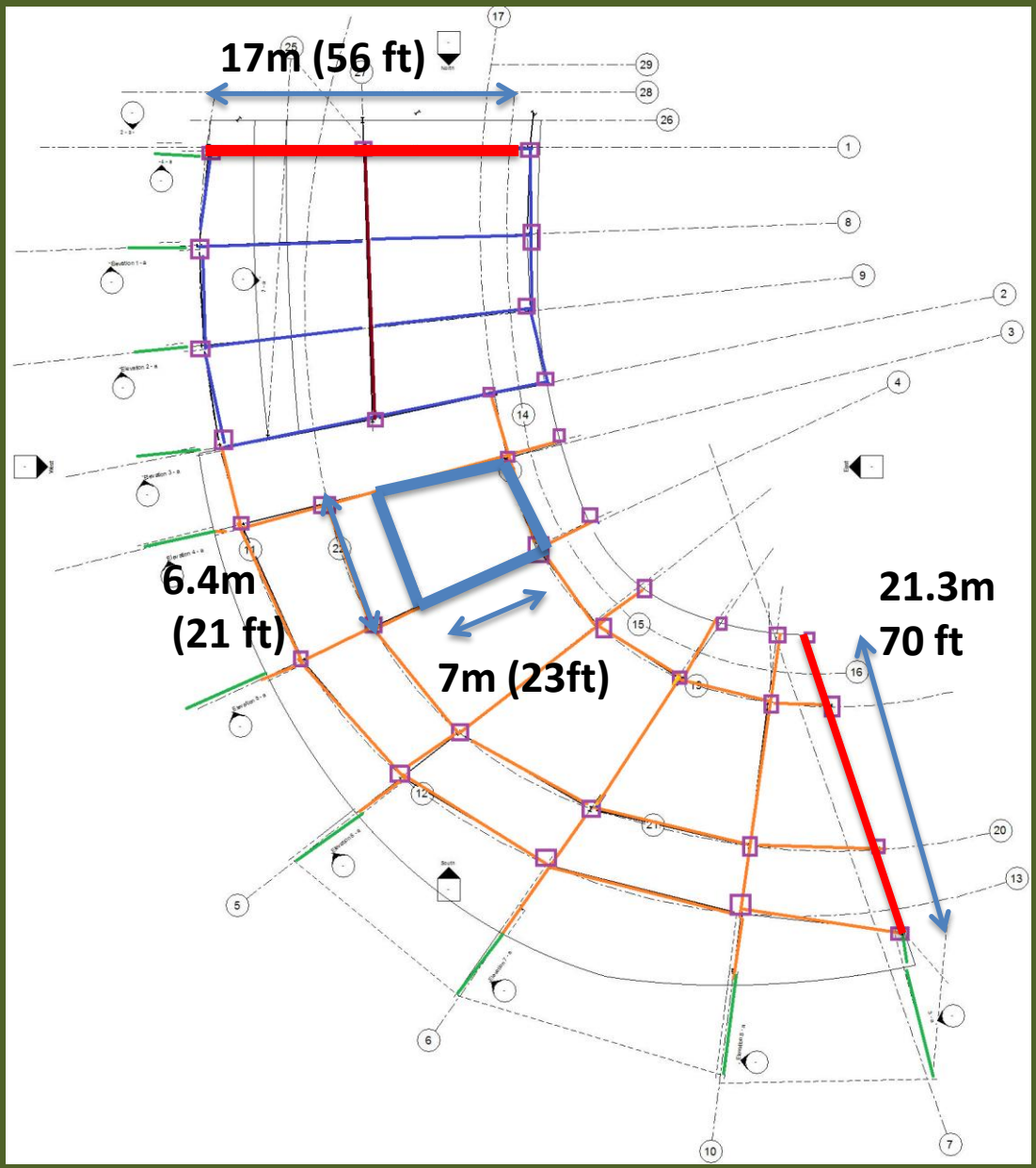
Gravity and Lateral System

Beams
- **W24x94**
- **W12x35**
- **W12x50**

Columns
W10x33

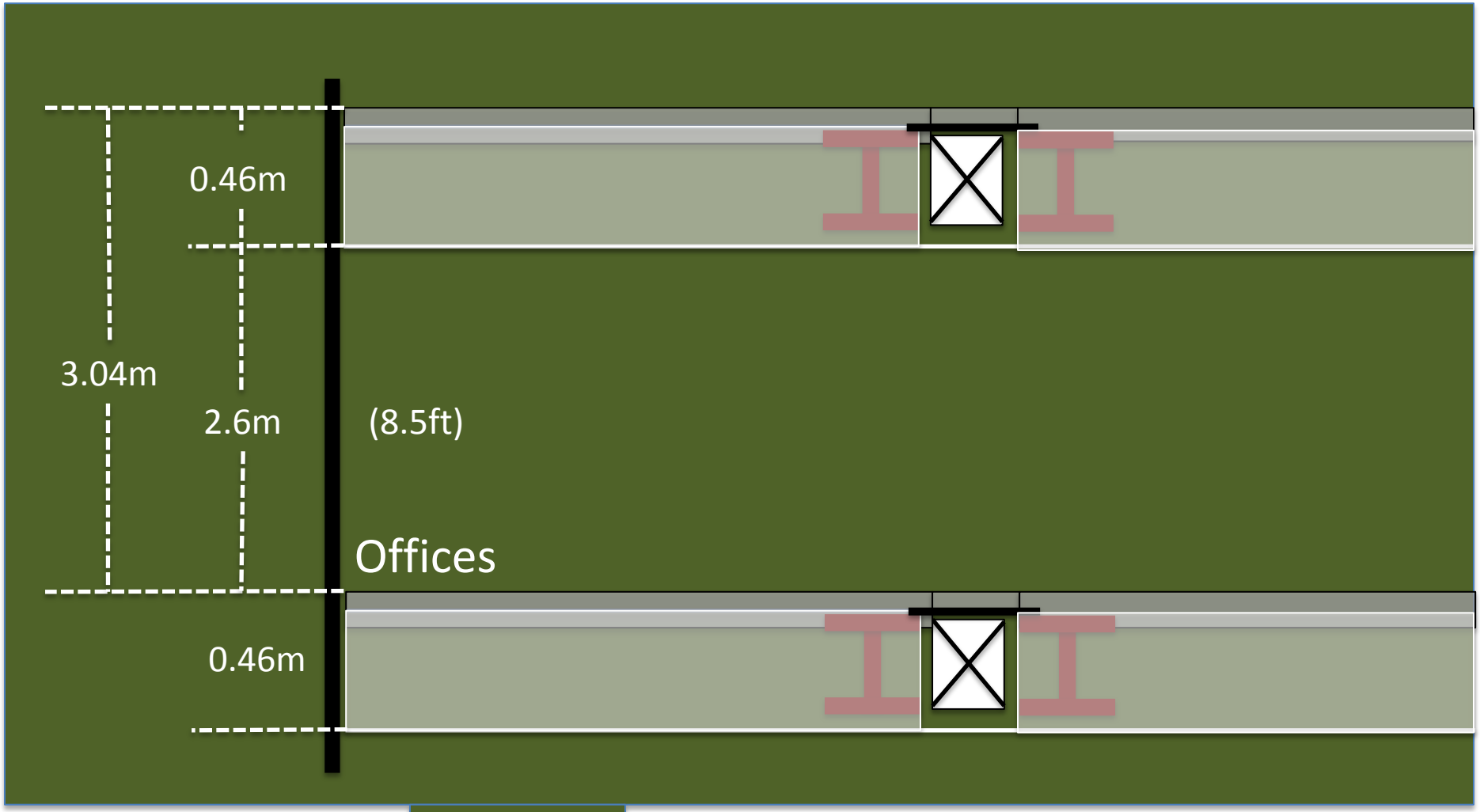
Roof Truss
- **HSS6x6x0.5**

- **Braced Frame**
- **RC Shear Wall**

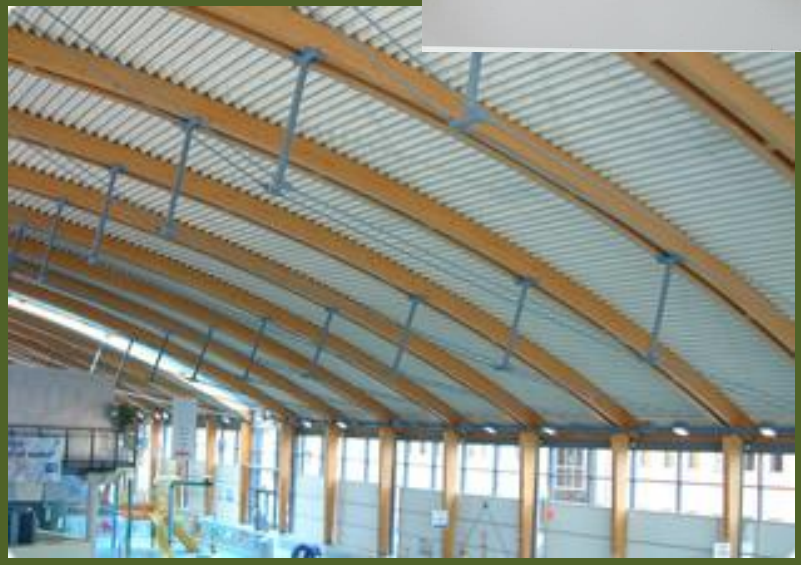


Floor Sandwich

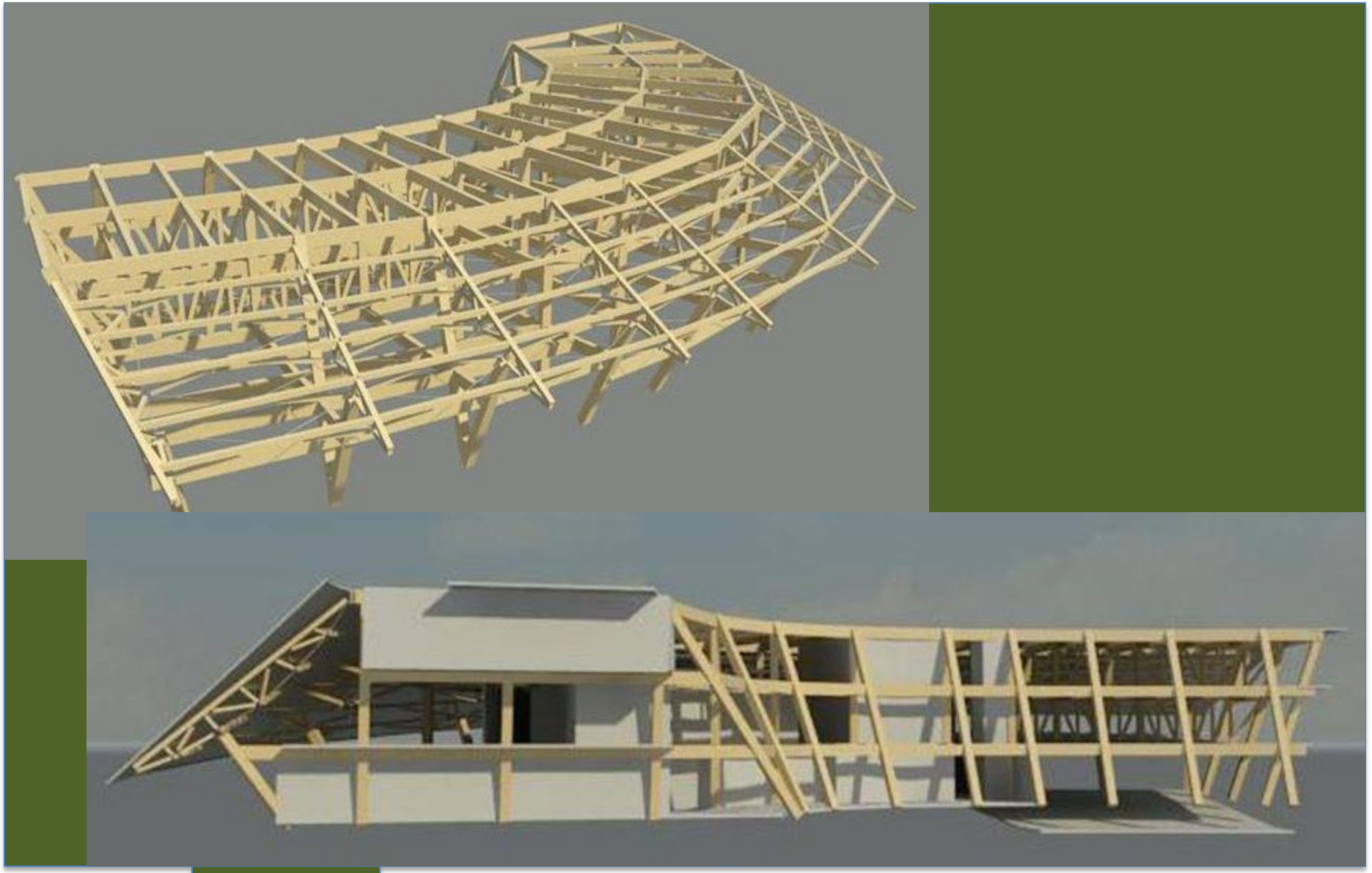
Typical Cross-section



Design Inspiration - Timber



Structural Rendering - Timber

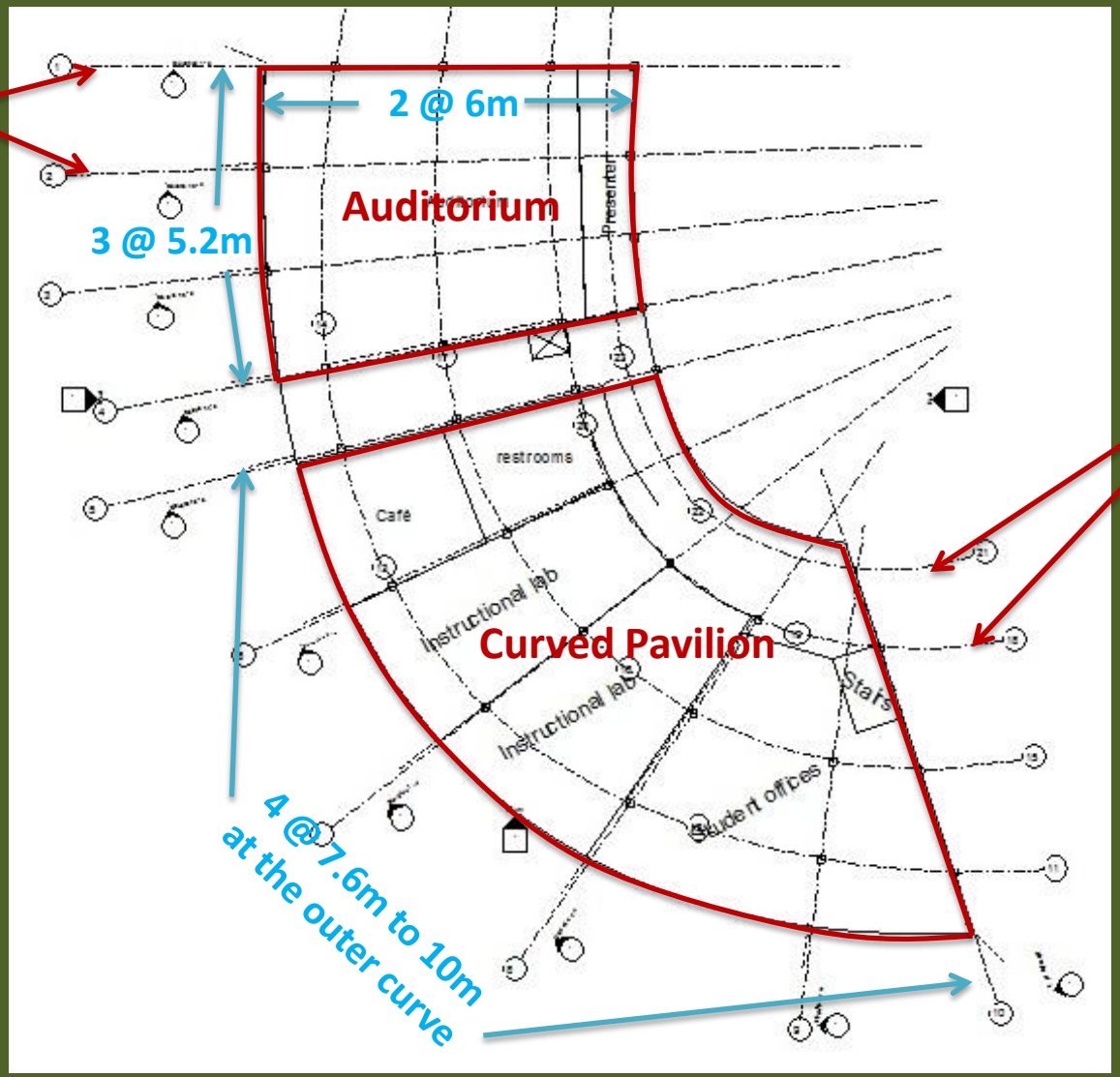


Structural rendering Timber

Grid Layout

Transversal Grid lines:

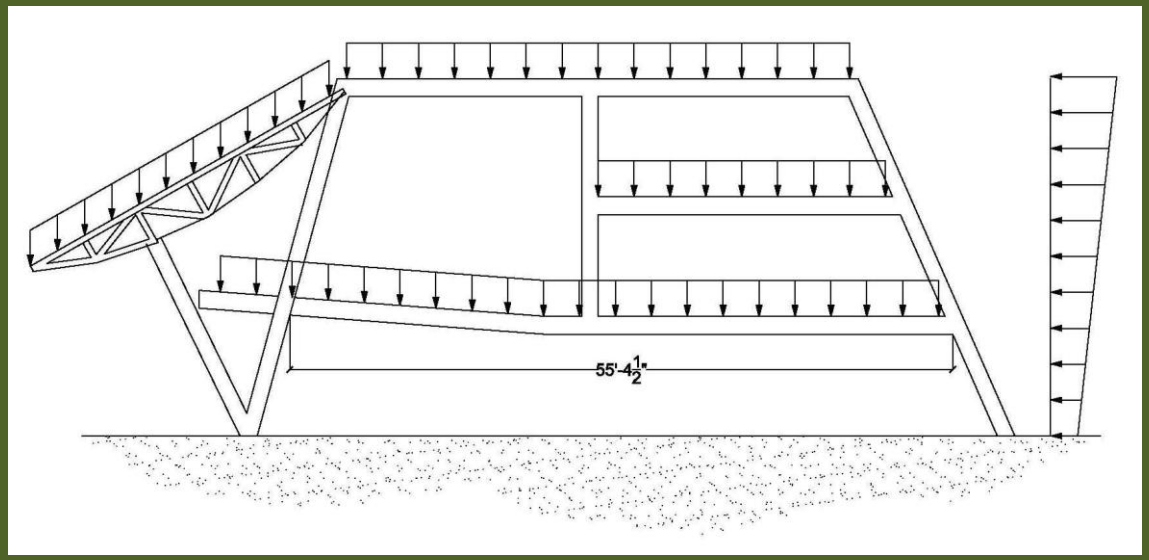
- 5.2m (17ft) span at the auditorium
- 11 to 15 degrees rotational span at the curved pavilion
- Transversal grid lines also define the diaphragm



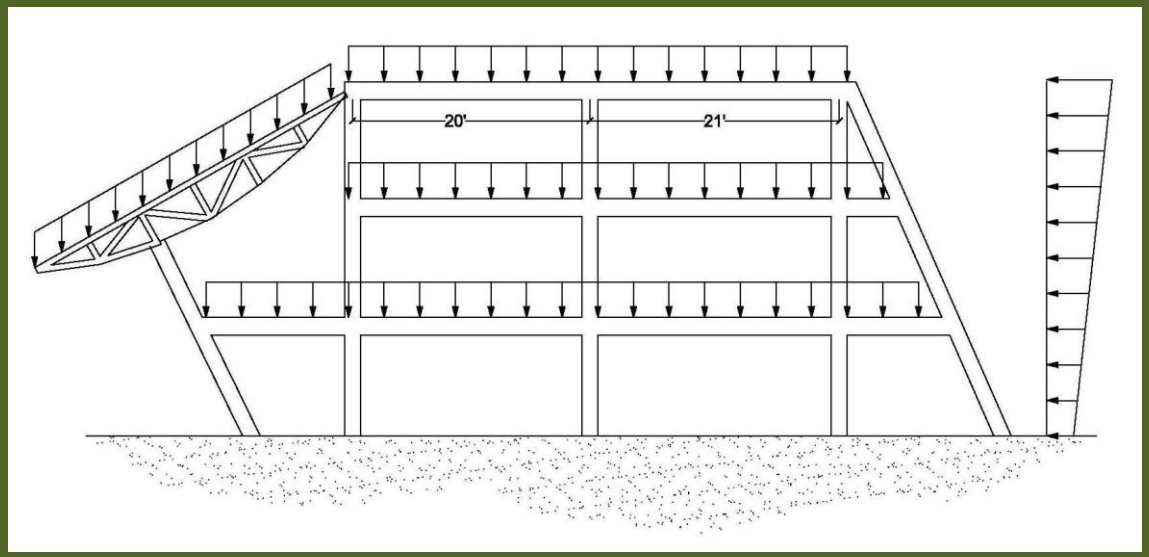
Longitudinal grid lines:

- 6m (20ft) span
- follow the shape of the building

Sections And Critical Loadings

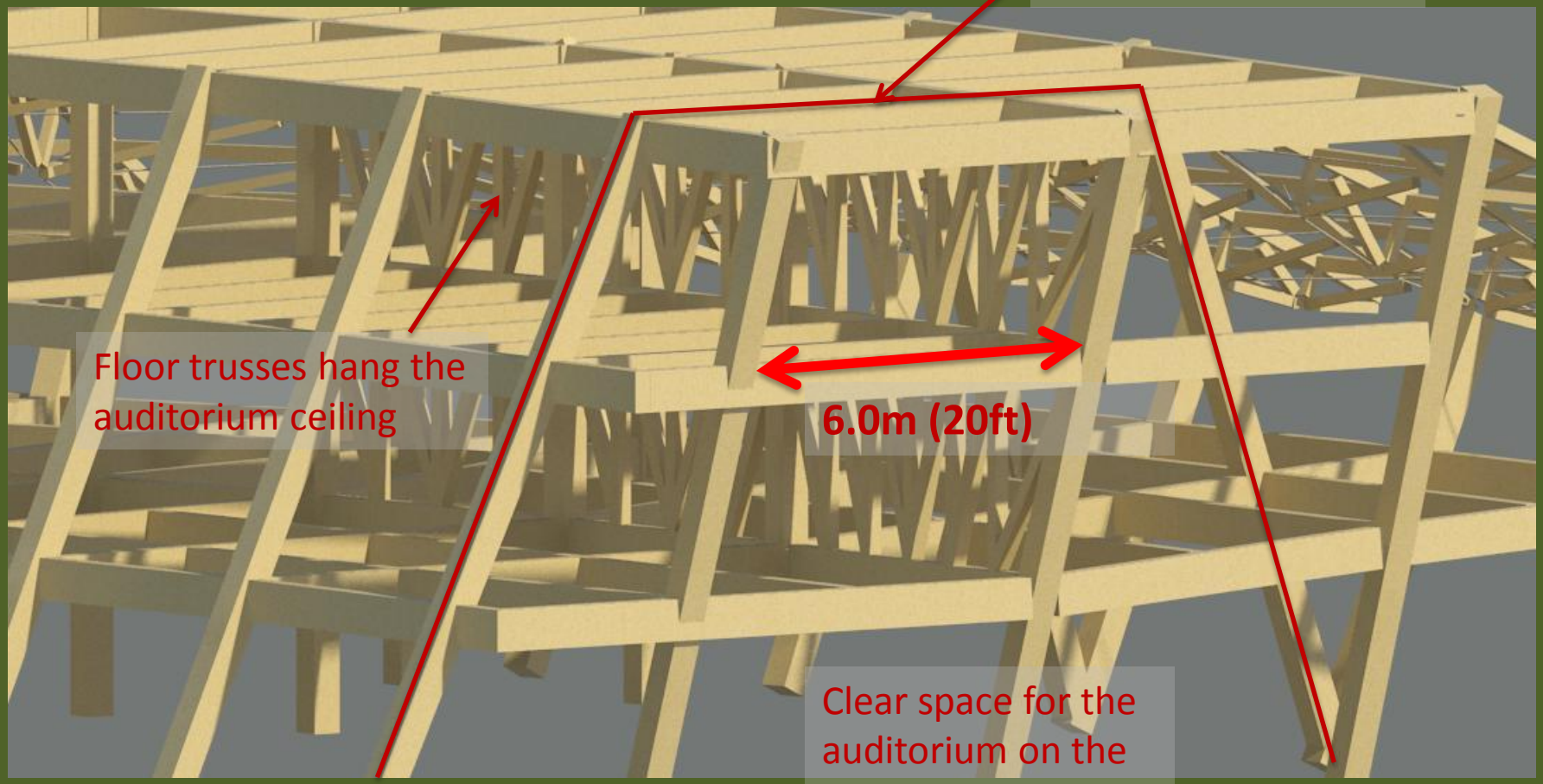


Auditorium Section and Load Profile

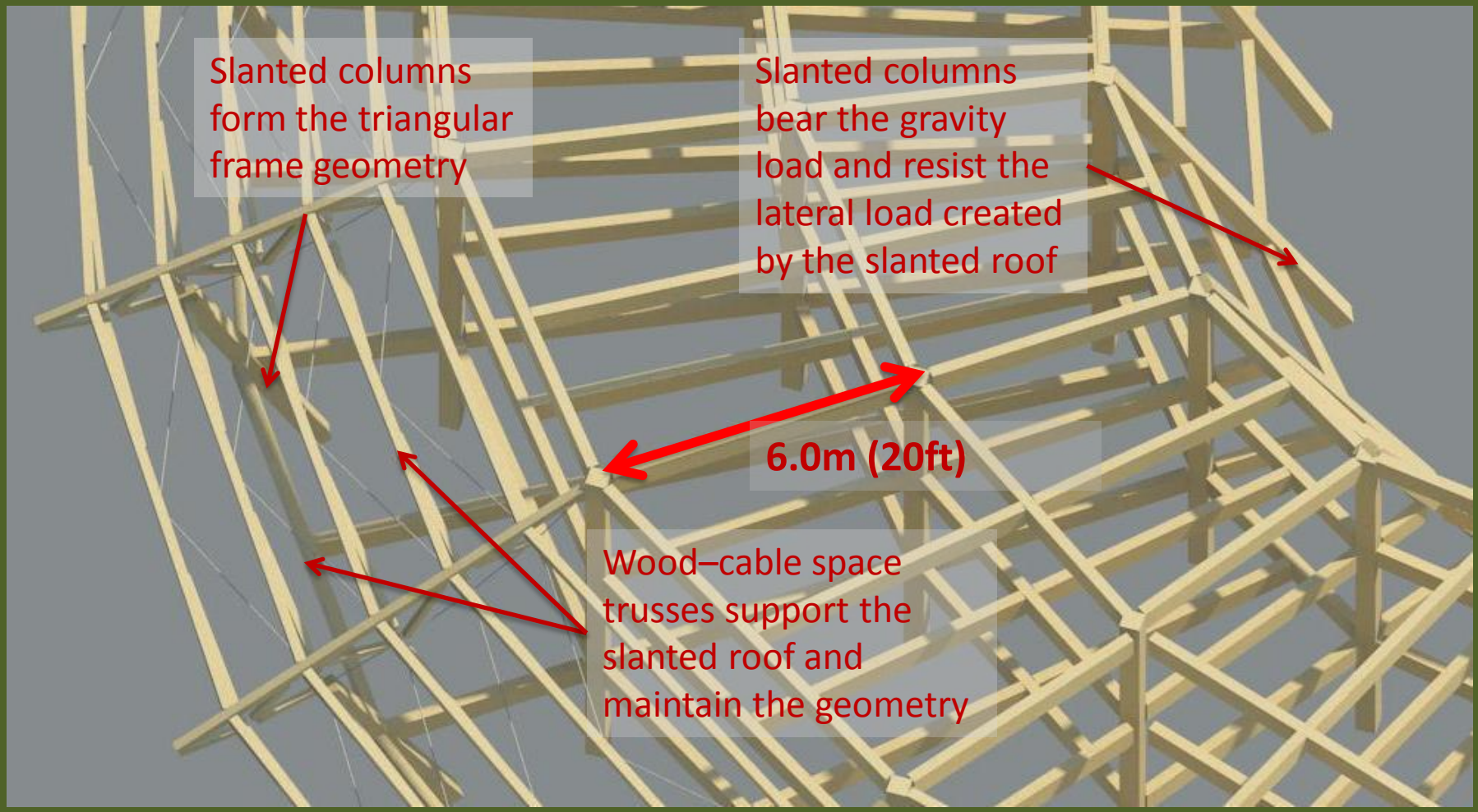


Curved Pavilion Section and Load Profile

Auditorium Framing Detail



Curved Pavilion Framing Detail



Design and Considerations

Design:

- Used glued laminated (glulam) timber as structural members

- Sizes

Further Challenges:

- Connections
- Consider torsion
- Need further consideration on the structure supporting the auditorium

MEP

Heating/Cooling

Climate Data

Month starting	HDD	CDD
1/1/11	977	0
2/1/11	903	0
3/1/11	749	0
4/1/11	376	0
5/1/11	287	8
6/1/11	150	17
7/1/11	173	9
8/1/11	114	32
9/1/11	187	12
10/1/11	513	3
11/1/11	804	0
12/1/11	815	0

MEP

Approach

- Cogeneration
  - Fuel Cells
  - Solar Cogeneration
- Dual Air Handling Units
  - Auditorium
  - Ventilation
- Distribution
  - Forced air (Aud.)
  - Radiant heat flooring

Natural Gas

Energy

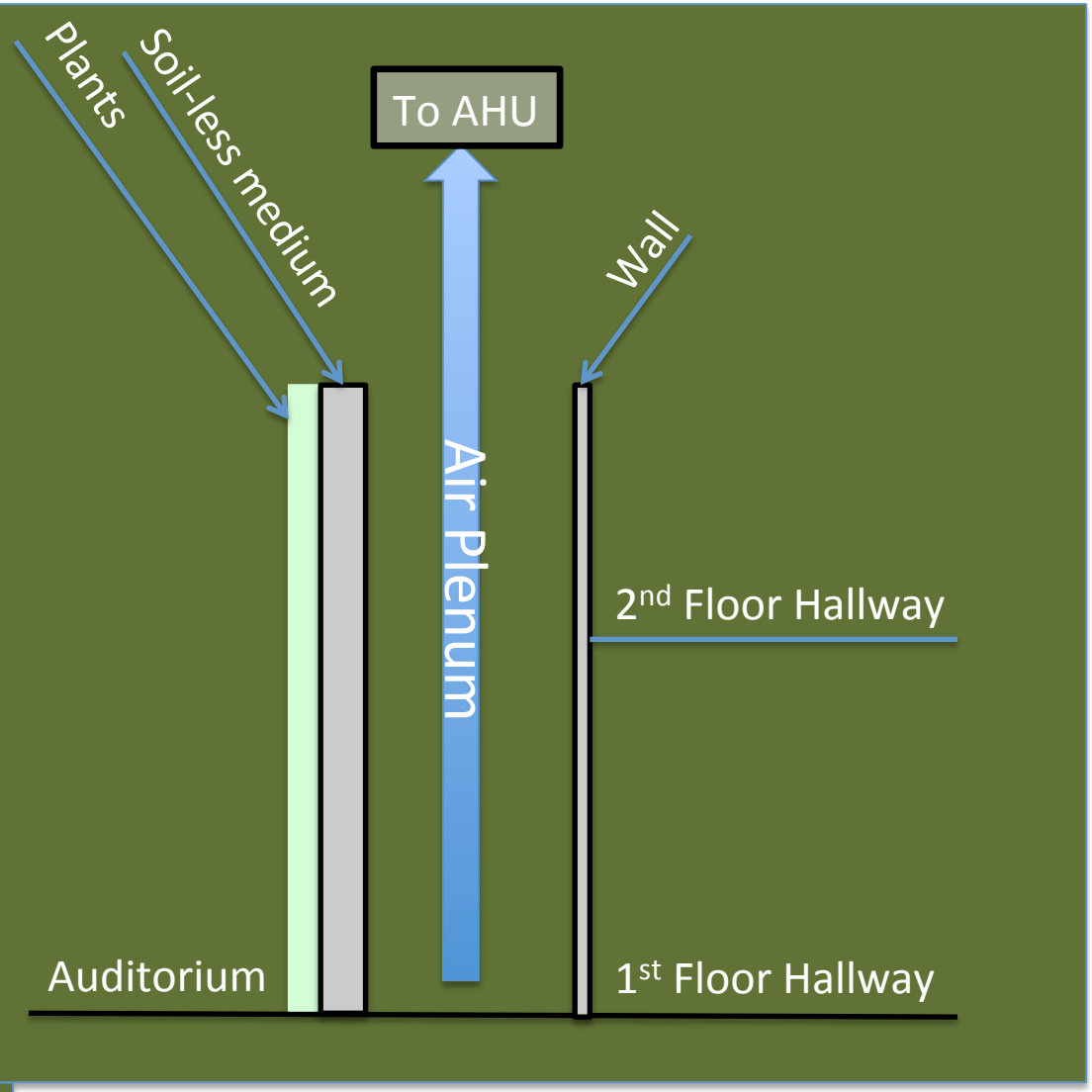
Hot Water

Solar

Energy

Waste Heat

BIOWALL


Plants
Soil-less medium
To AHU
Wall
Air Plenum
2nd Floor Hallway
Auditorium
1st Floor Hallway

Net Zero Building

Feasibility Check

Price per kW system	$6,867.21	US Case Studies
Price per kW system	$3,700.00	German Average

NET ZERO TARGET

Solar Energy Generation Potential (Weimar)		
Solar Radiation	3.32	kWh/m2/day
Area of Footprint	929.00	m2
Year	365	days
Efficiency	18.00%	
Solar Potential	**202,637.20**	**kWh/year**

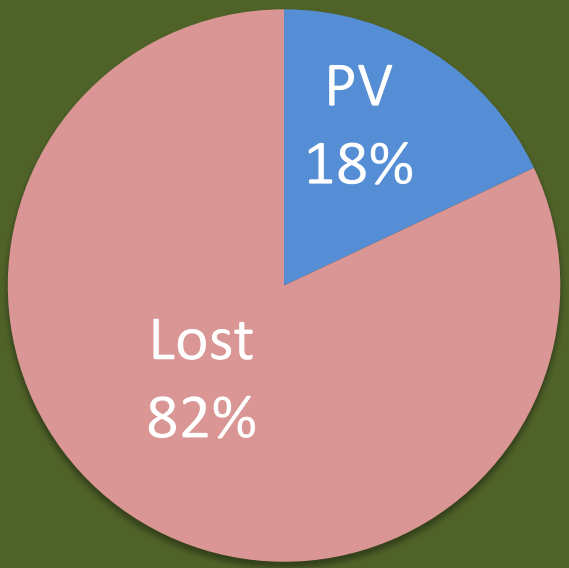
Target Consumption	**23,048.63**	**Btu/sf/yr**
	555.1704	kWh/day

System Size: 101kW

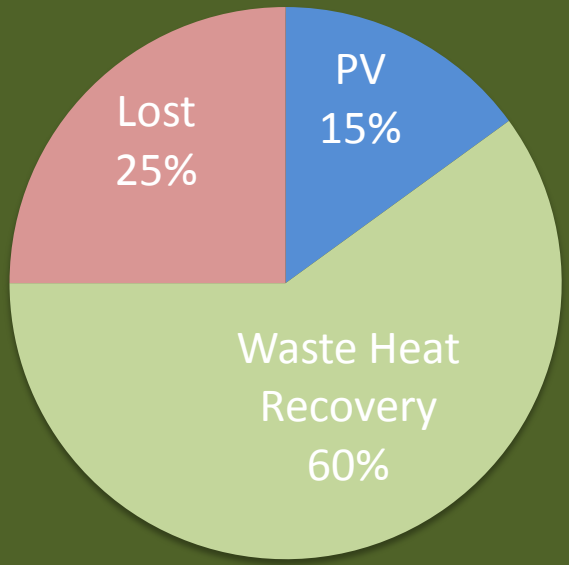
Solar Cogeneration

Efficiency Gains

PHOTOVOLTAICS

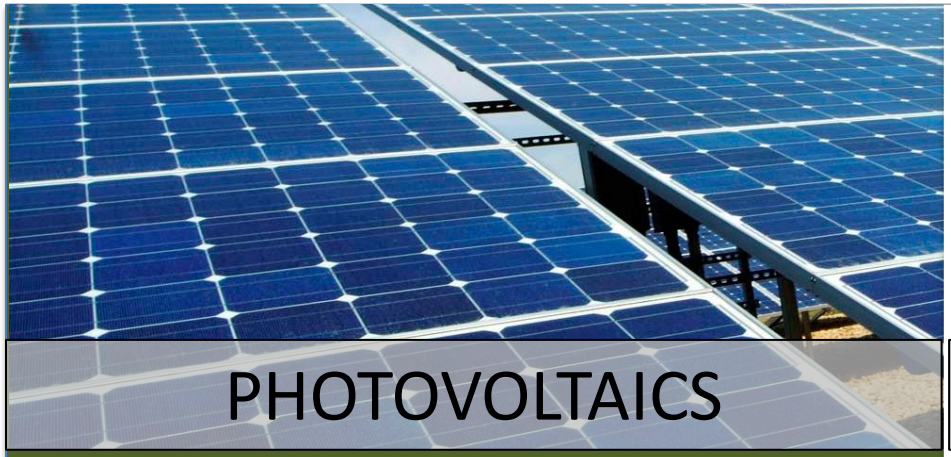


SOLAR COGENERATION

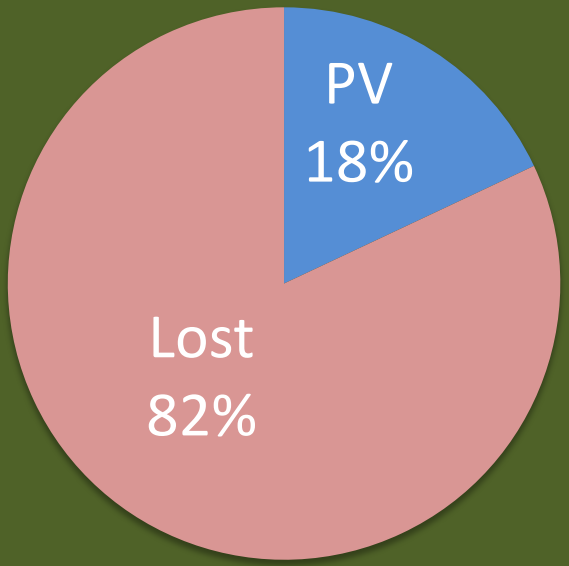


Solar Cogeneration

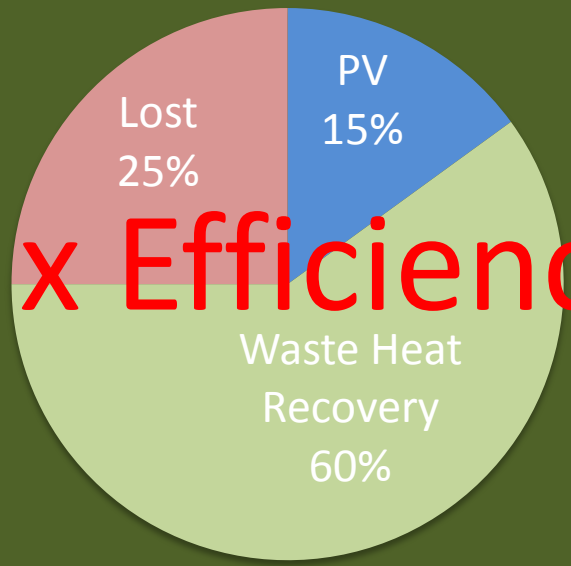
Efficiency Gains



PHOTOVOLTAICS



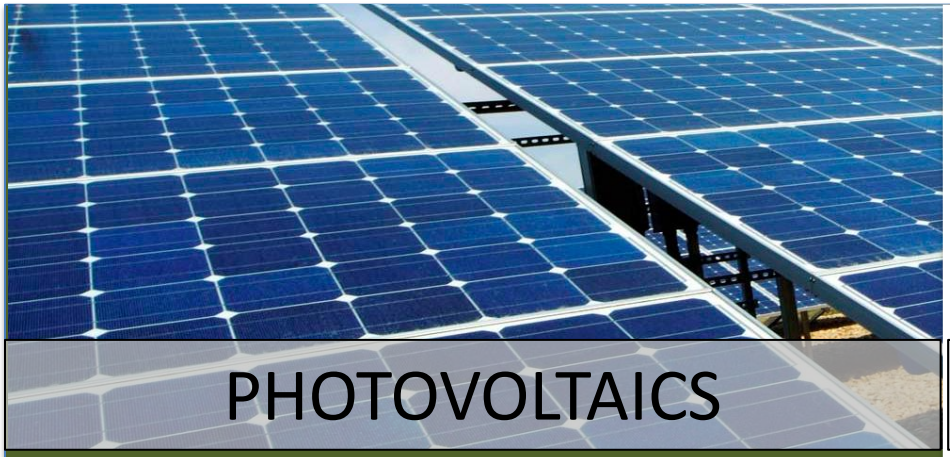
SOLAR COGENERATION



5 x Efficiency

Solar Cogeneration

Efficiency Gains



PHOTOVOLTAICS

10,000 SF

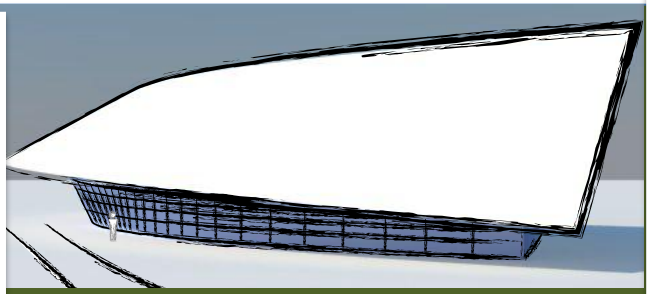
SOLAR COGENERATION

2,600 SF

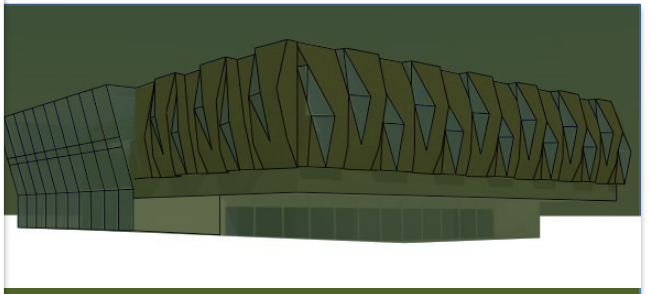
Solar Cogeneration

Efficiency Gains

PHOTOVOLTAICS



2,000 SF



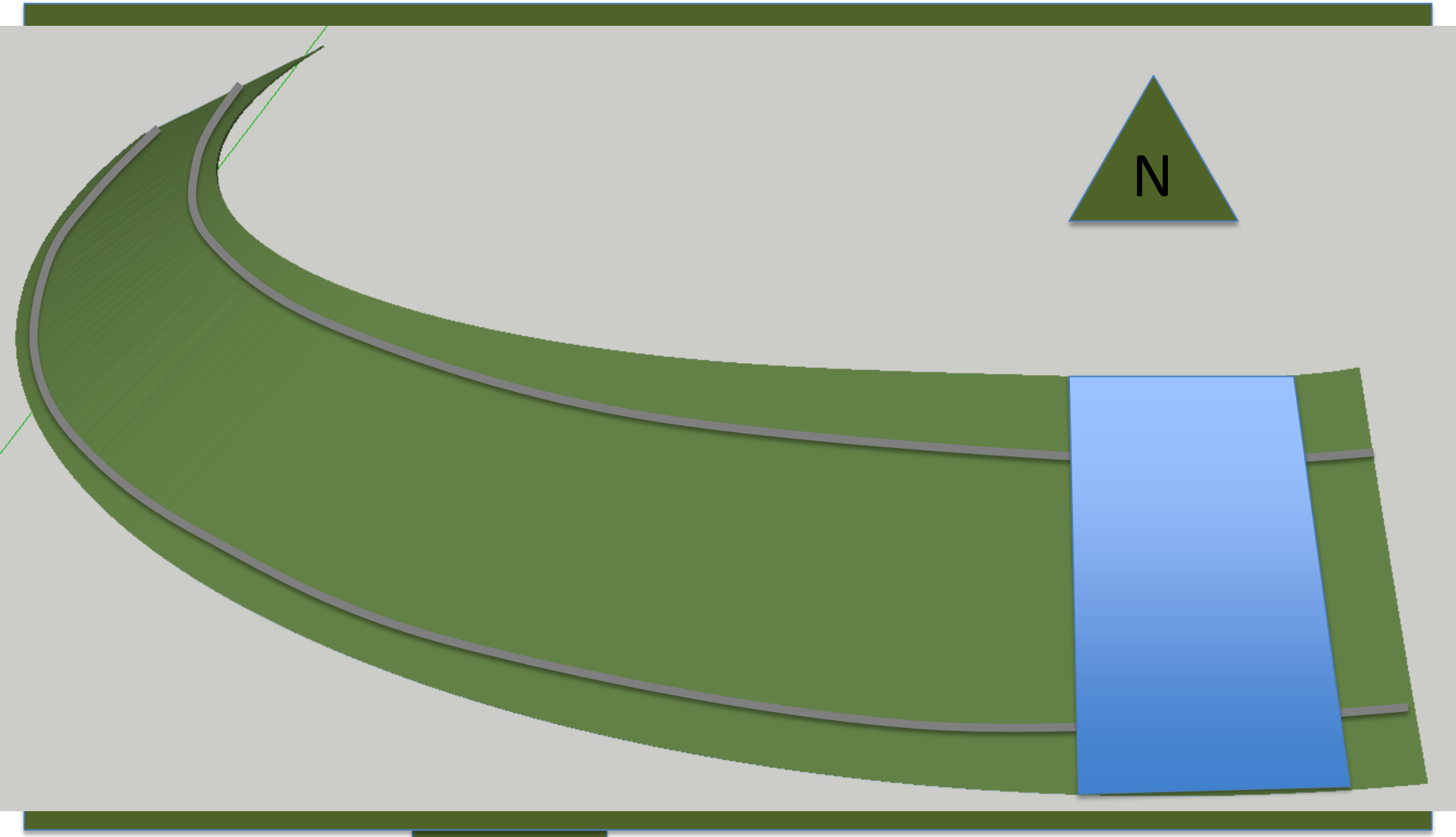
0 SF

SOLAR COGENERATION

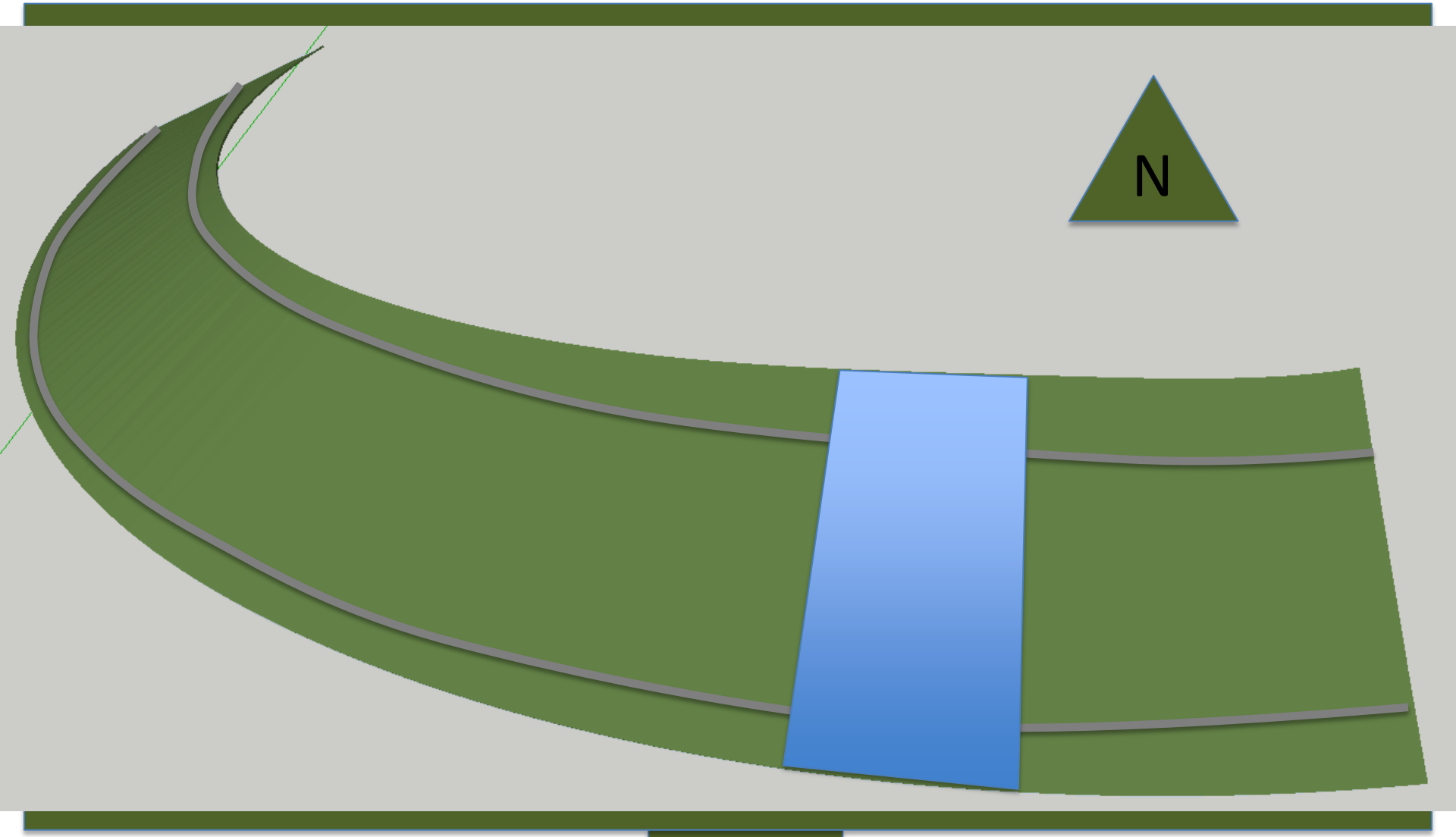
2,000 SF

2,600 SF

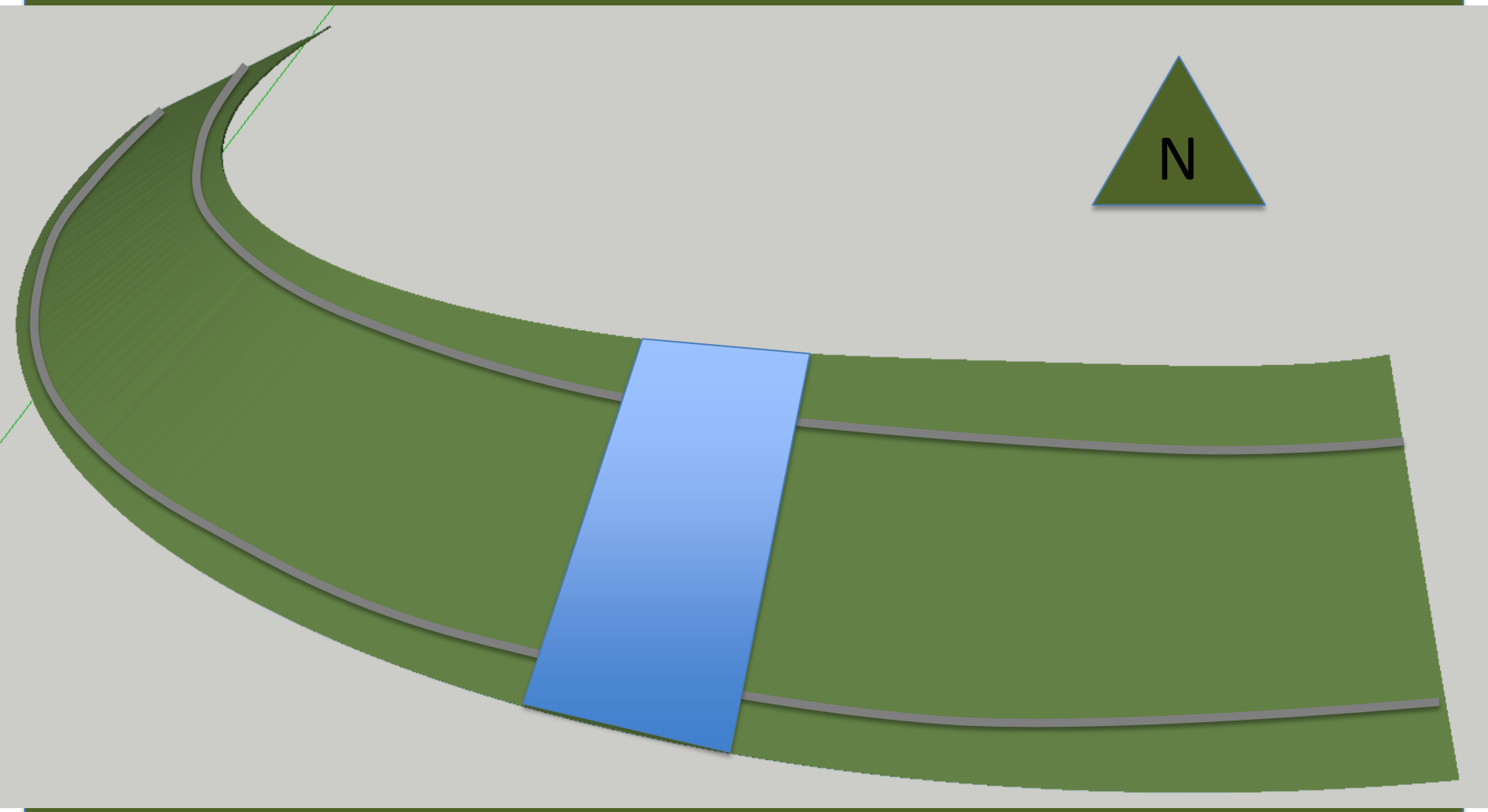
Solar Tracking



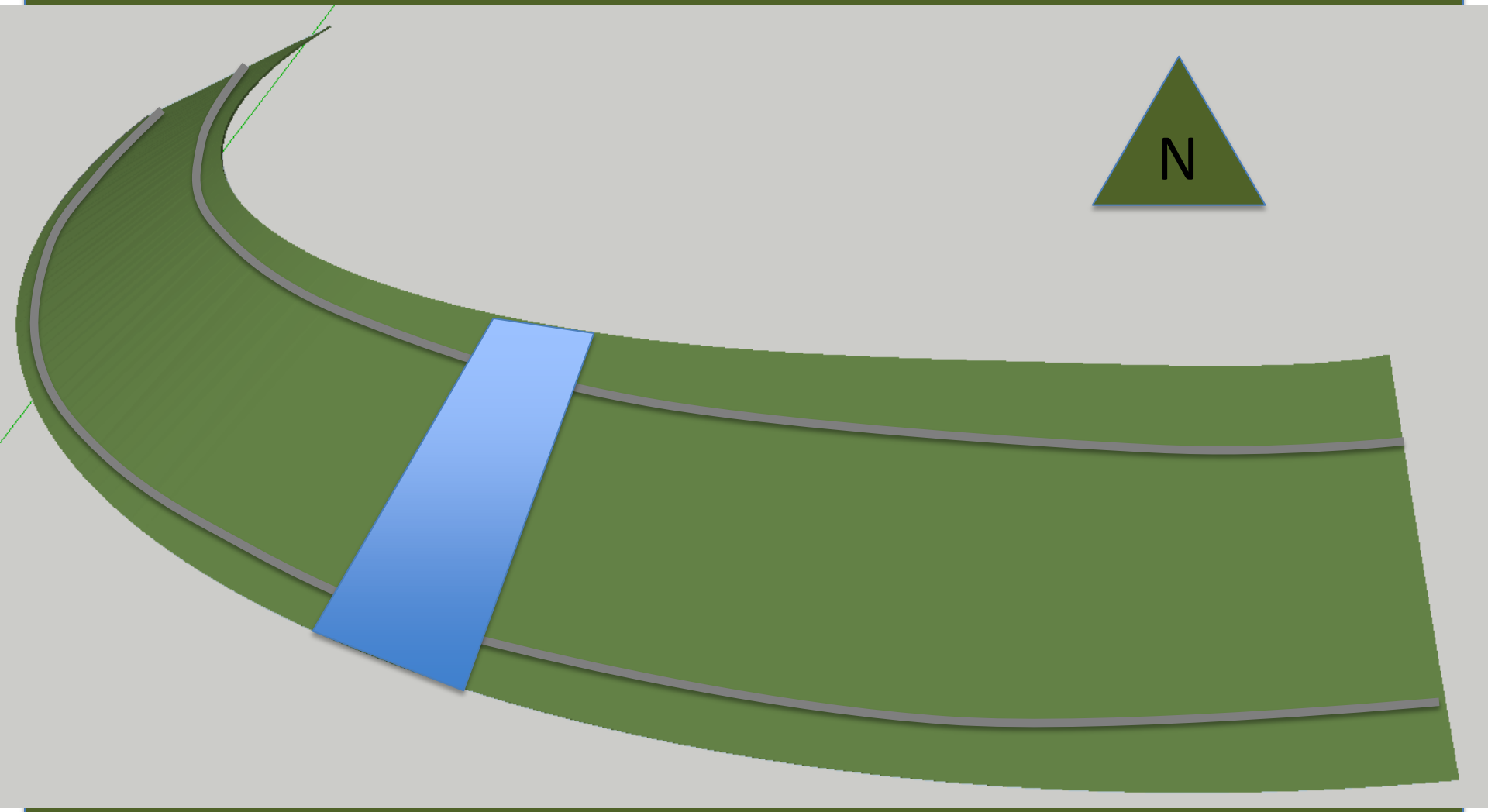
Solar Tracking



Solar Tracking



Solar Tracking



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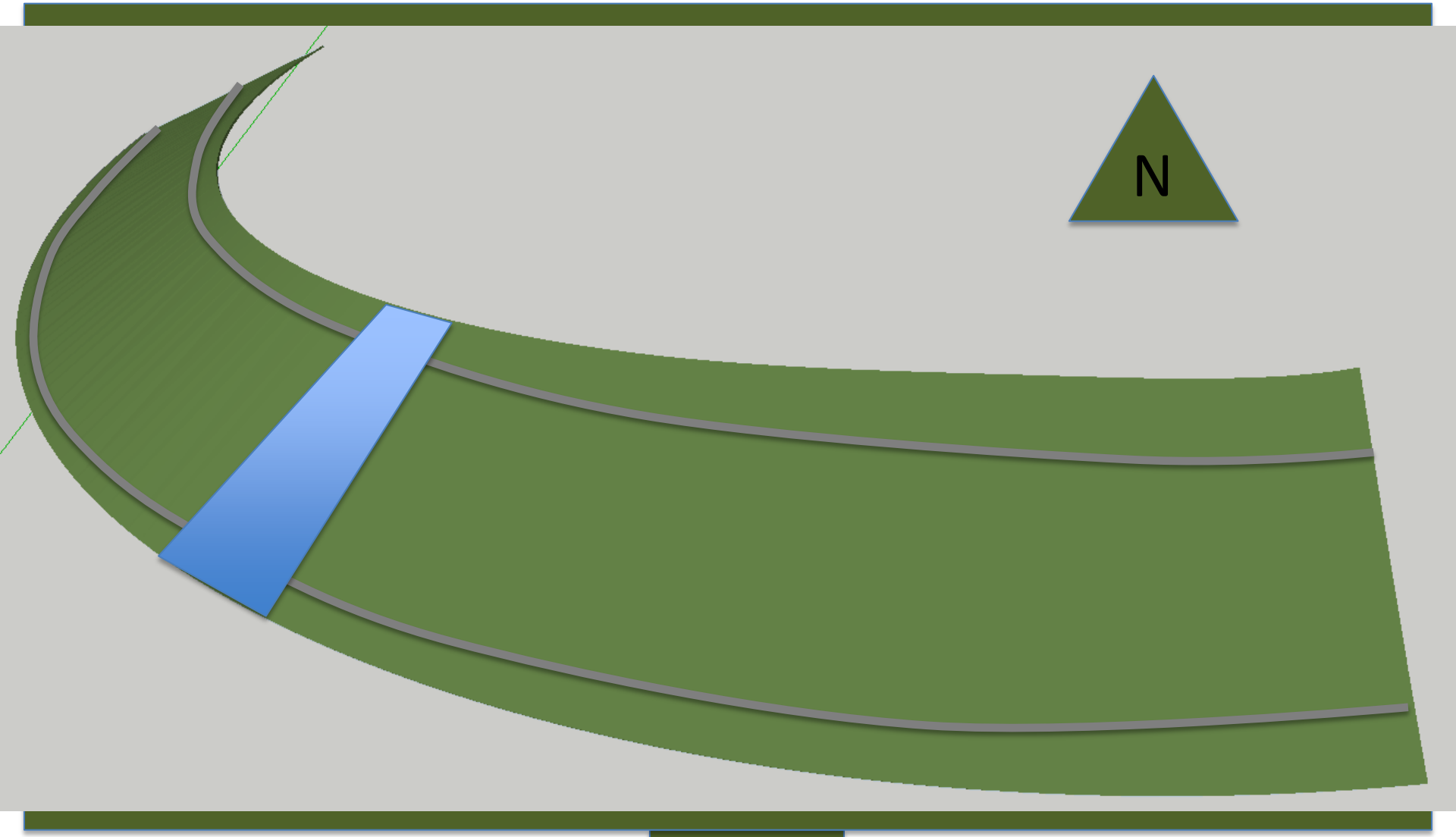
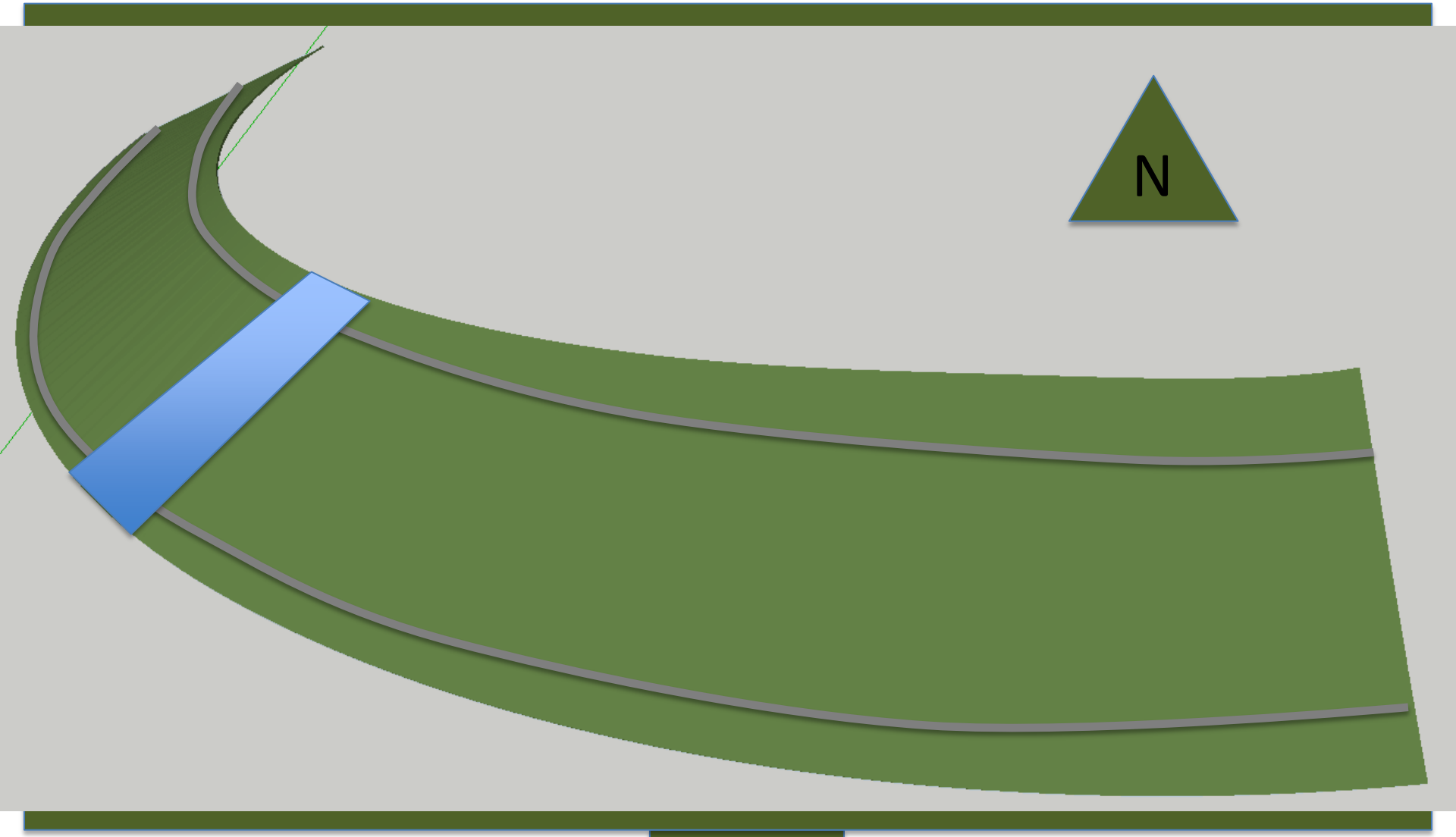
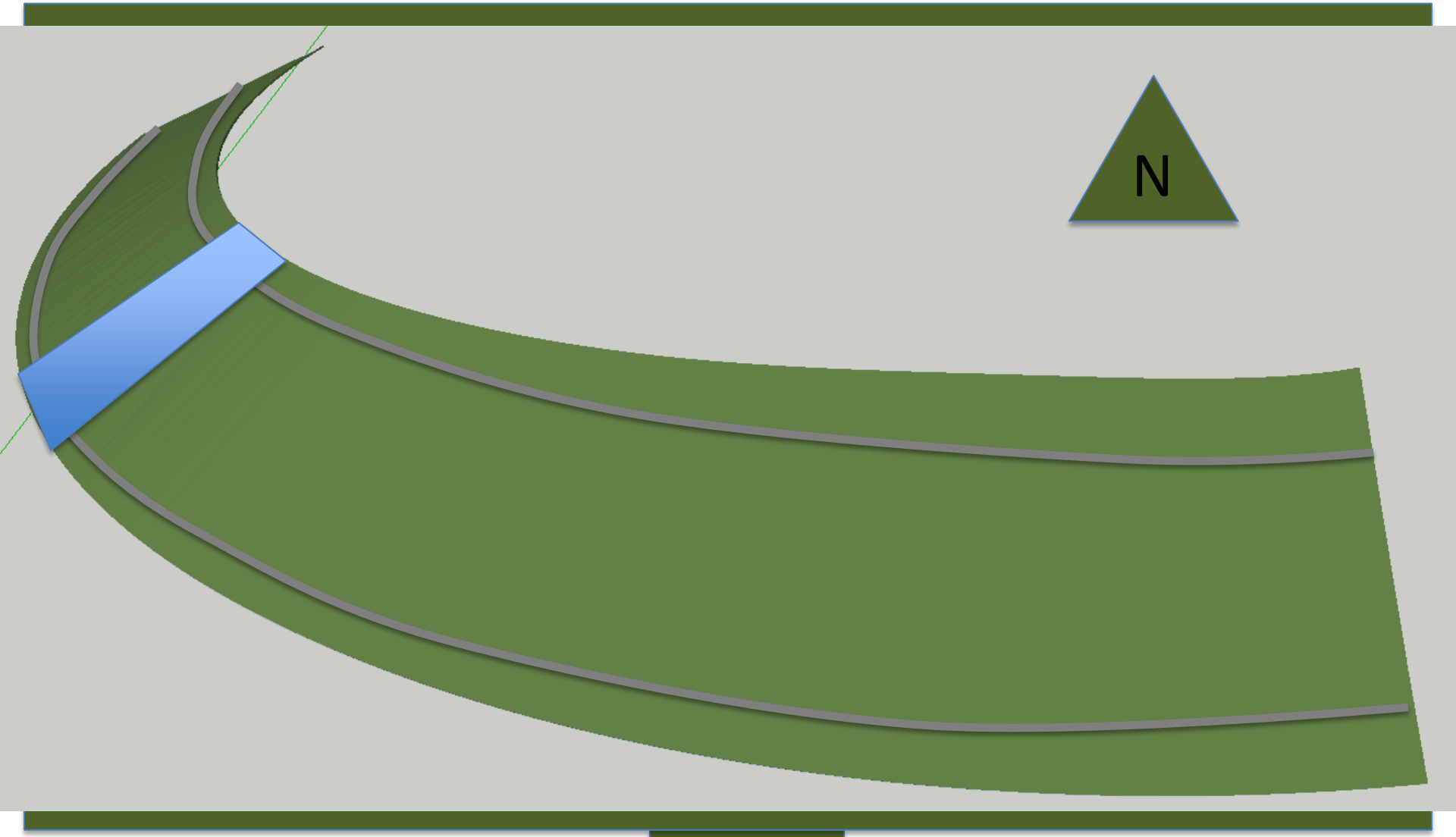


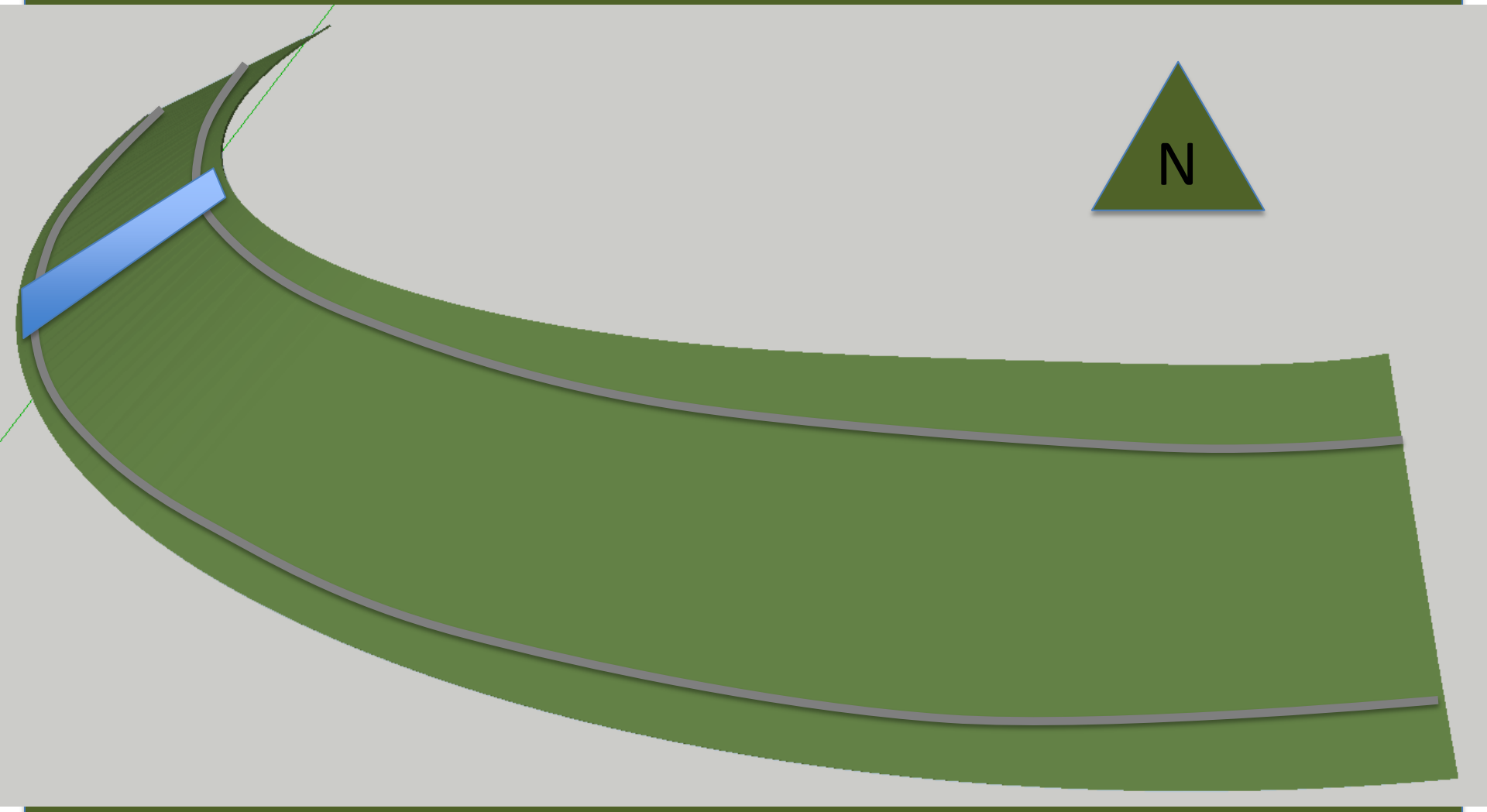
Solar Tracking



Solar Tracking

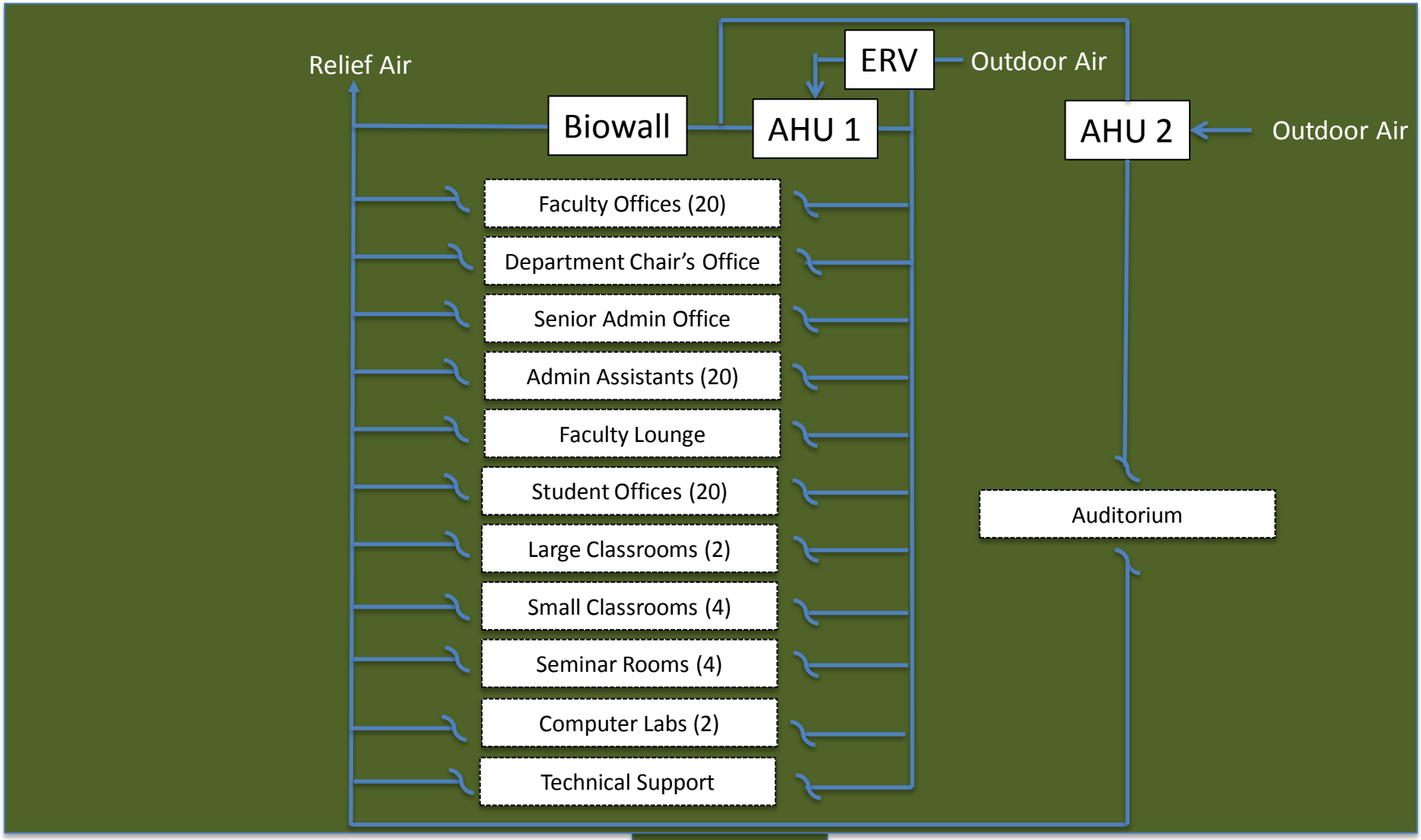


Solar Tracking



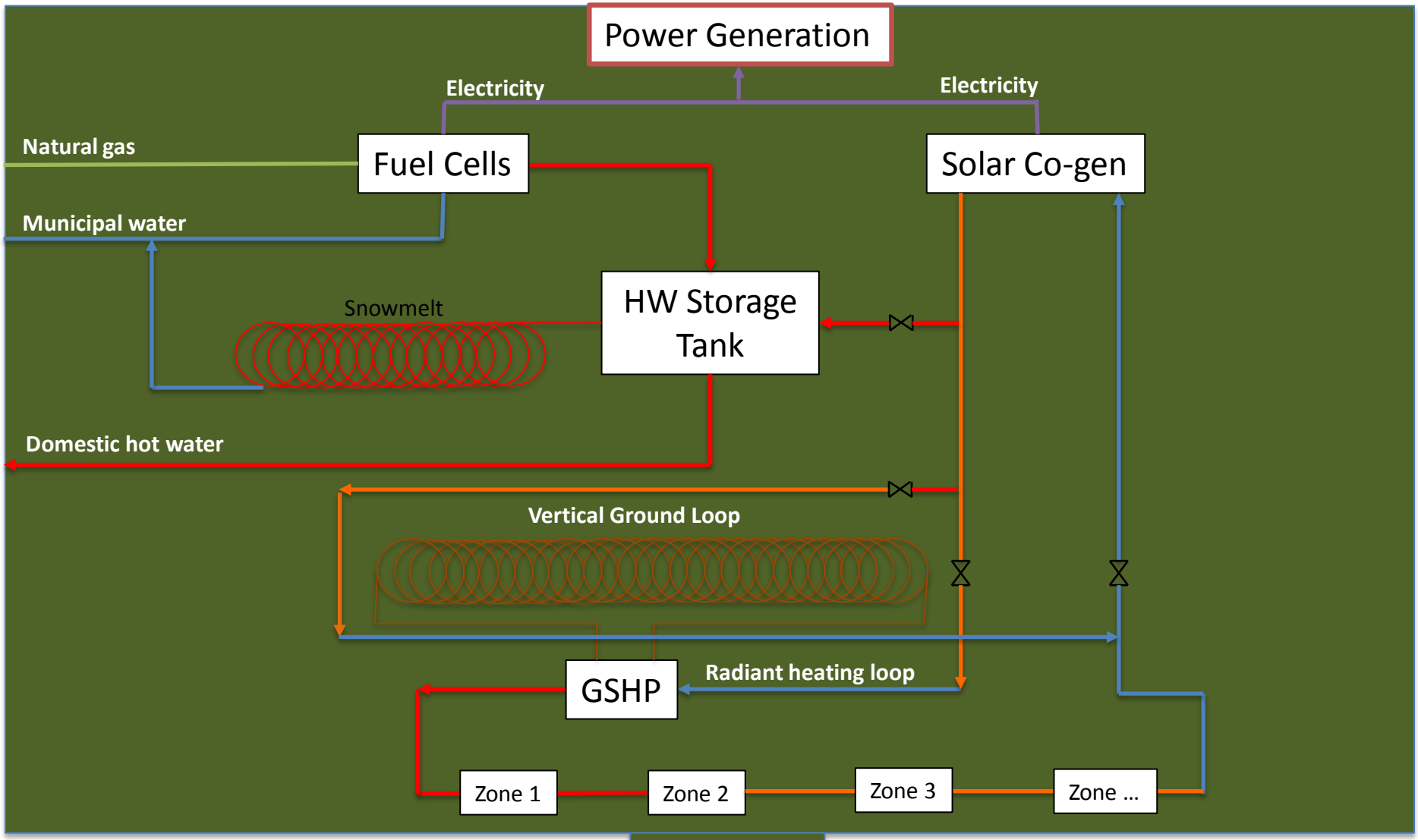
Ventilation

Schematic



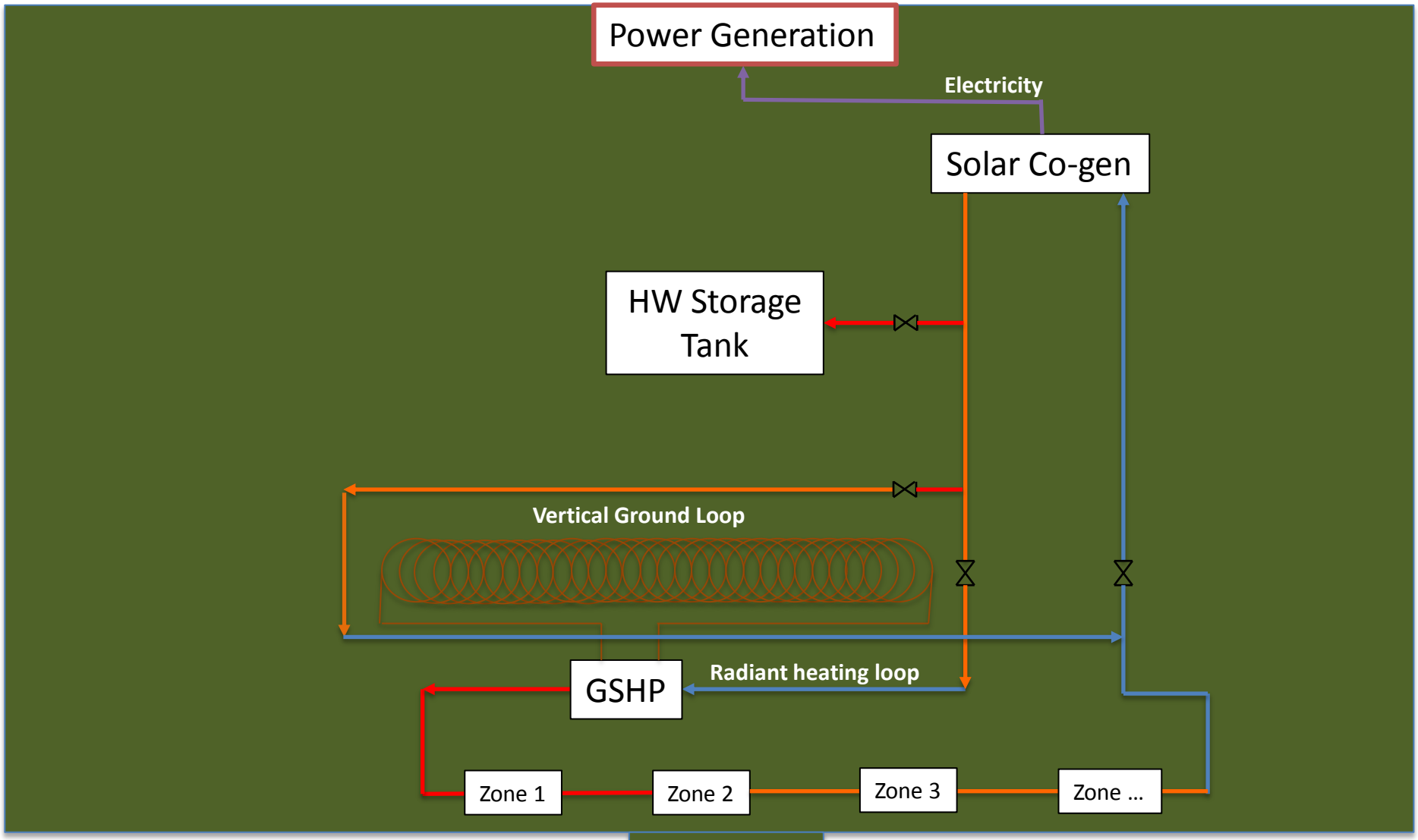
Heating/Cooling

Schematic



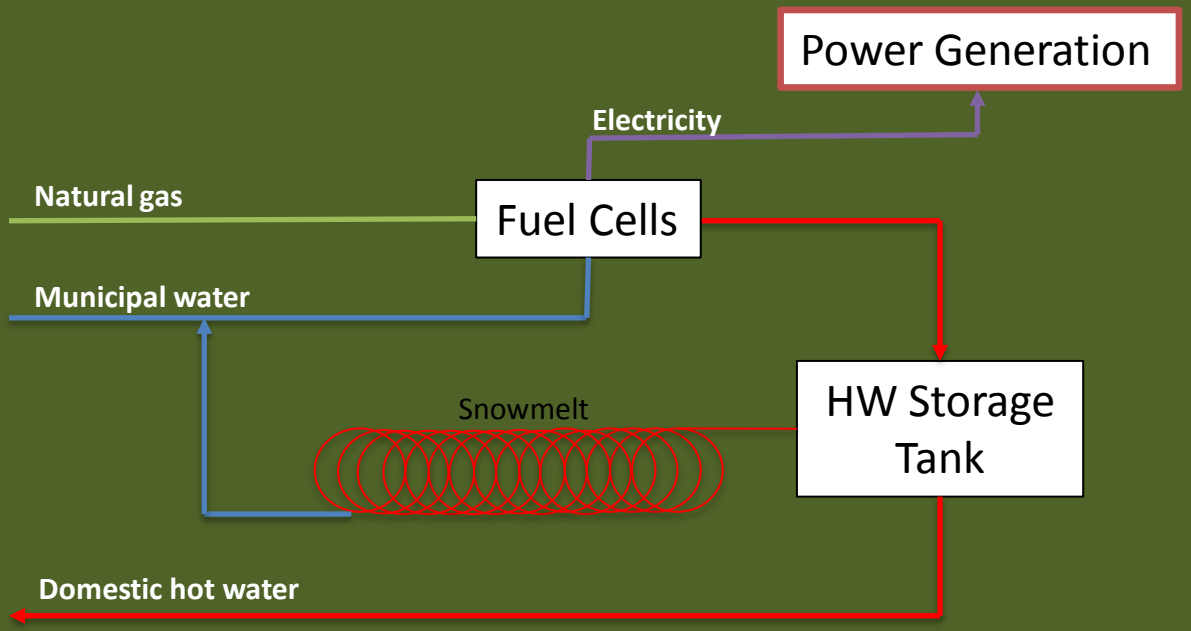
Heating/Cooling

Schematic – Solar CoGen



Heating/Cooling

Schematic – Fuel Cell



Construction

Logistics Plan

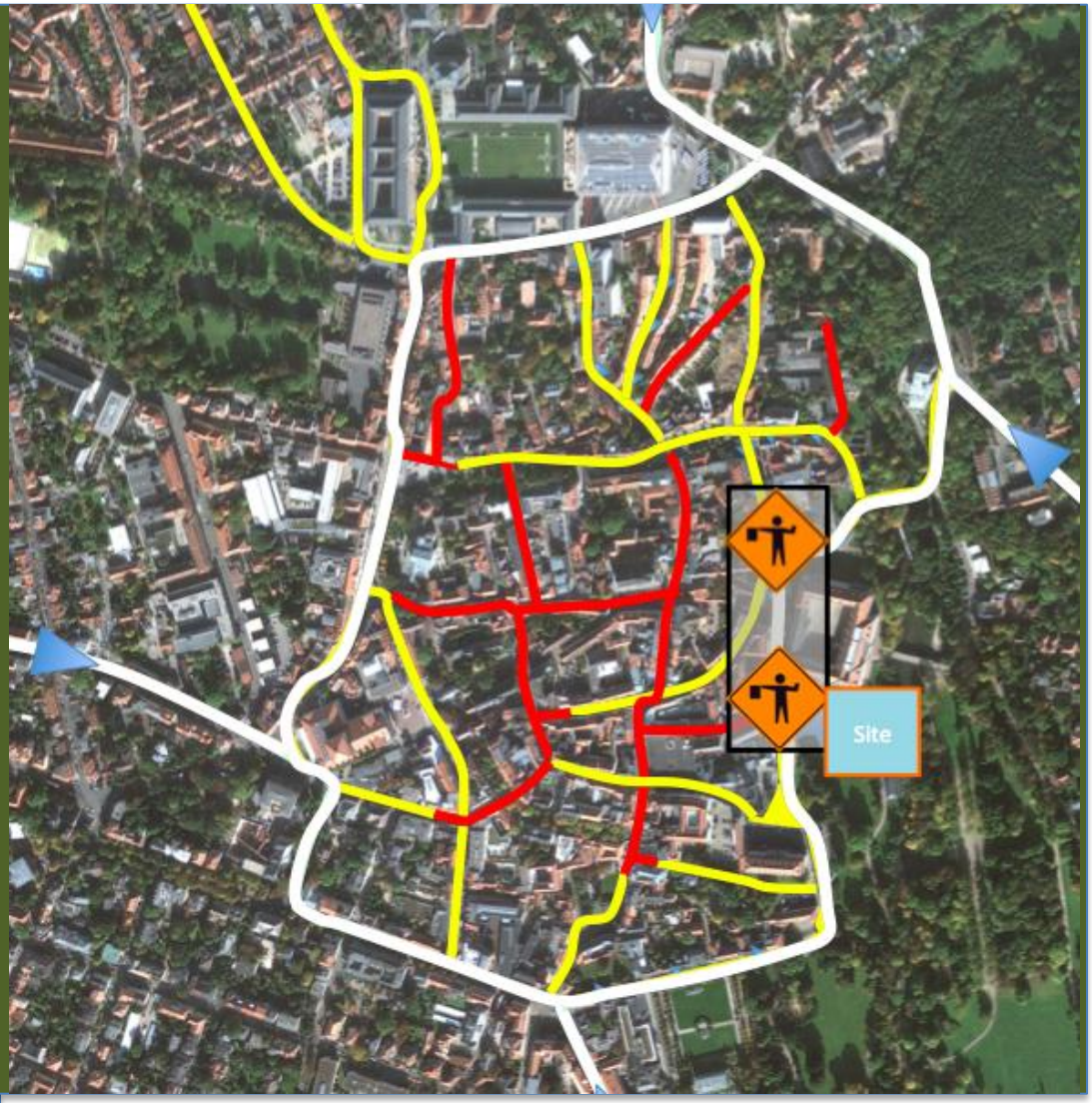
Site Access Limitations

- Streets
  - Narrow
  - Unusable
  - One way

Good Access

Slow Access

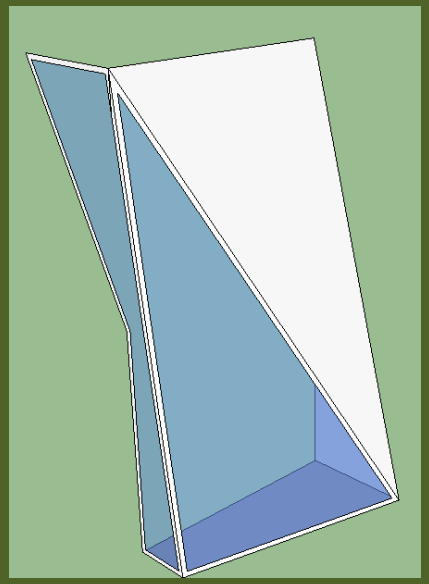
No Access

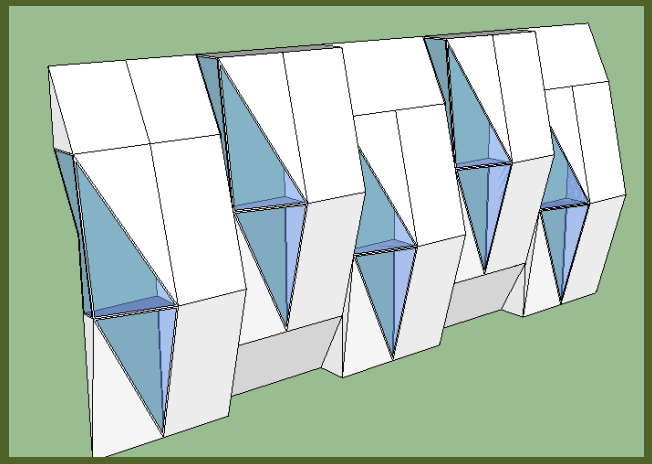


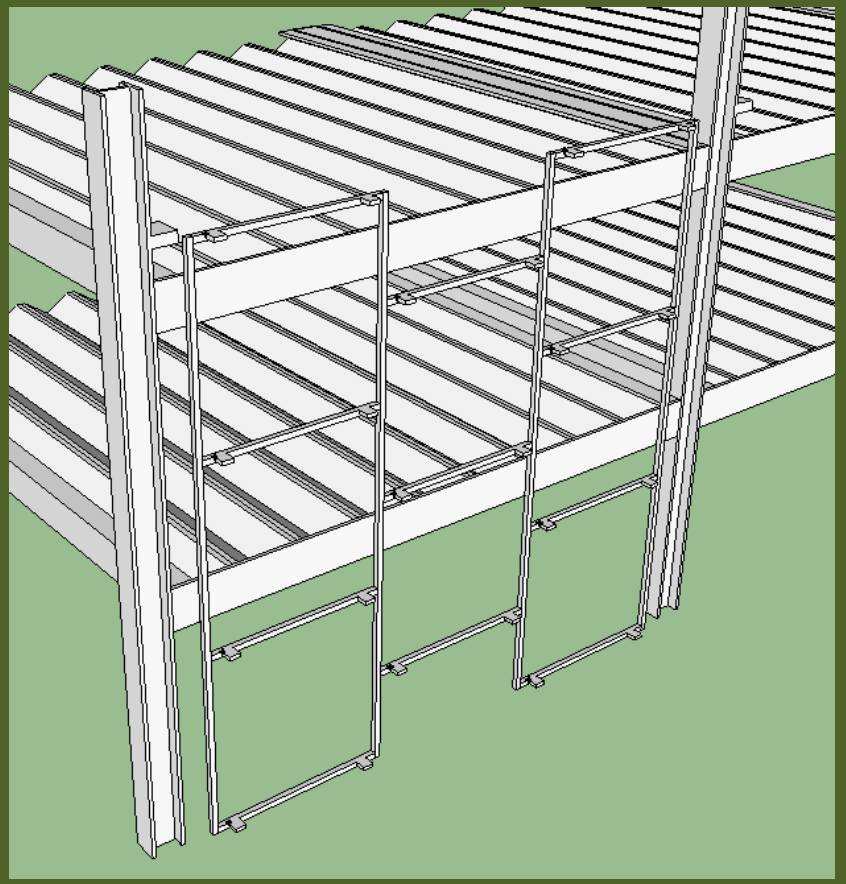
Prefabrication

Façade

- SIPS
- Curtainwall
- Orientation



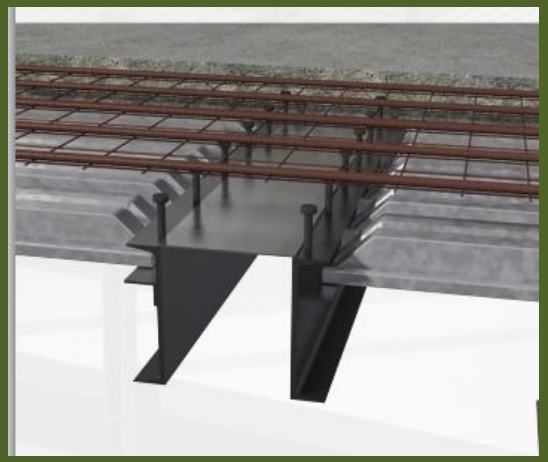


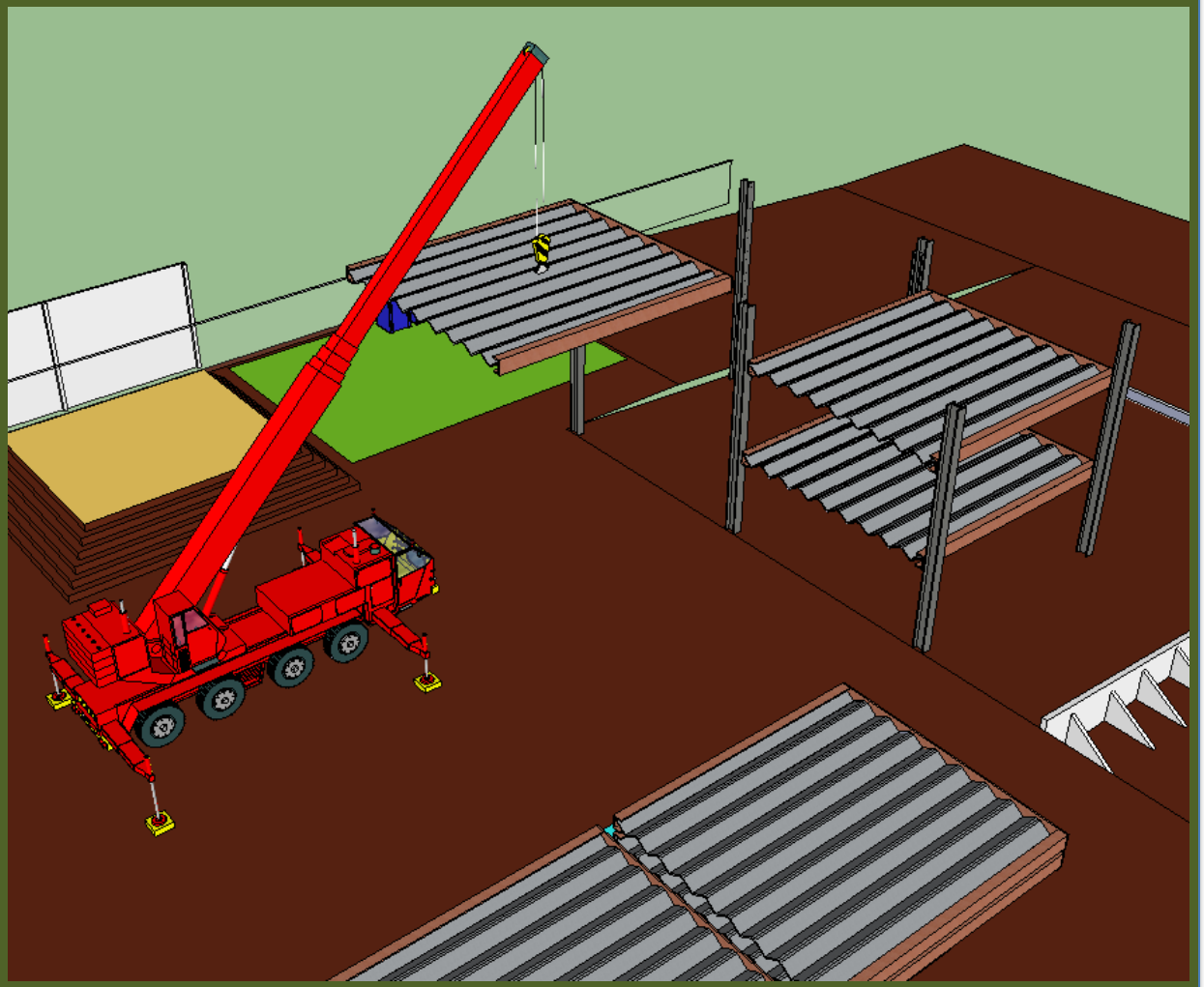


Prefabrication

Structural Steel

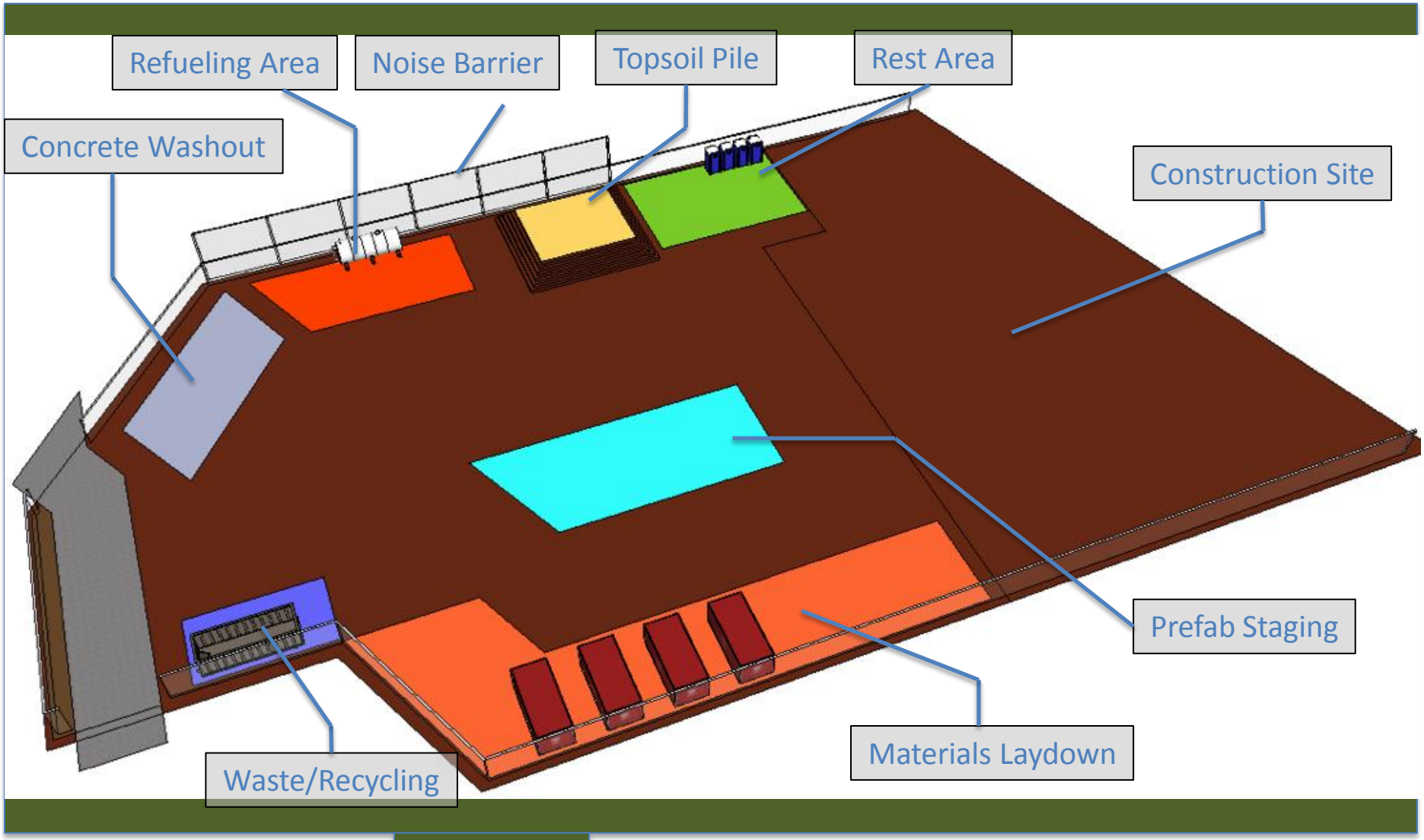
- Prefabbed onsite
- MEP chaseway
- 50% schedule reduction





Logistics

Site Plan



Local Materials

Target Costing

Determining Value Needed

Avg. Baseline Est.	$5,898,878
Budget	$7,878,874
Value Needed	$1,979,996

Target Costing

Owner Targets

Please rate each category as to the importance of spending money on that item. Note that some categories fall under several different areas.

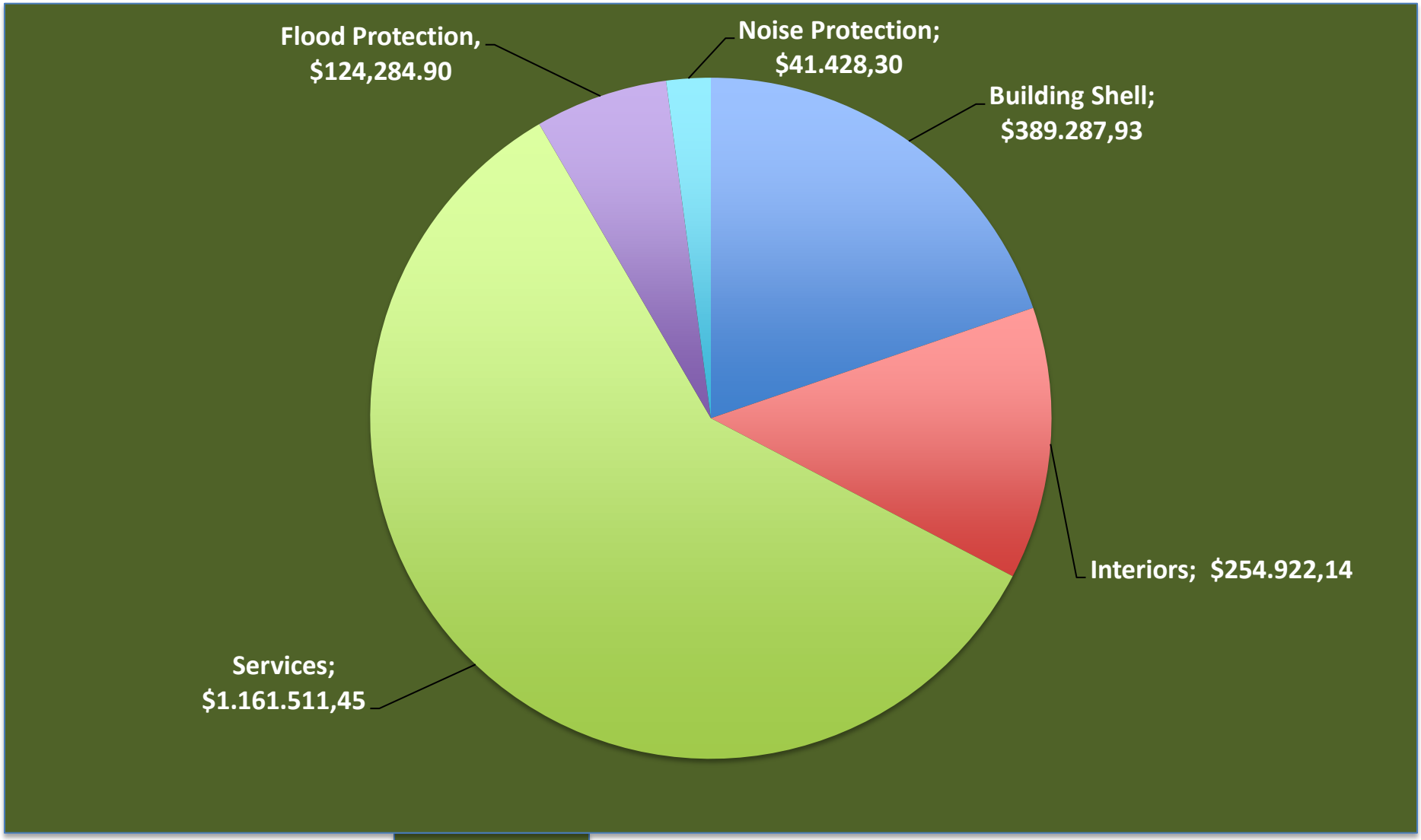
Cluster	Category	Owner 1	Owner 2	Average
Building				
B. Shell	Roof System	0	0	0
B. Shell	Exterior Façade	0	0	0
B. Shell	Exterior Doors	0	0	0
D. Services	HVAC System	0	0	0
D. Services	Indoor Air Quality - Bio Wall/ERV	0	0	0
D. Services	Security	0	0	0
G. Building Sitework	Landscaping	0	0	0
Construction	Flood Protection	0	0	0
Construction	Noise Protection	0	0	0
Auditorium				
B. Shell	Windows	0	0	0
C. Interiors	Interior Doors	0	0	0
C. Interiors	Finishes	0	0	0
C. Interiors	Fittings	0	0	0
D. Services	Lighting	0	0	0
D. Services	Thermal Comfort	0	0	0
Classrooms				
B. Shell	Windows	0	0	0
C. Interiors	Interior Doors	0	0	0
C. Interiors	Finishes	0	0	0
C. Interiors	Fittings	0	0	0
D. Services	Lighting	0	0	0
D. Services	Thermal Comfort	0	0	0
Computer Labs				
B. Shell	Windows	0	0	0
C. Interiors	Interior Doors	0	0	0
C. Interiors	Finishes	0	0	0
C. Interiors	Fittings	0	0	0
D. Services	Lighting	0	0	0
D. Services	Thermal Comfort	0	0	0
Extra Income				
B. Shell	Windows	0	0	0
C. Interiors	Interior Doors	0	0	0
C. Interiors	Finishes	0	0	0
C. Interiors	Fittings	0	0	0
D. Services	Lighting	0	0	0
D. Services	Thermal Comfort	0	0	0
Faculty Lounge				
B. Shell	Windows	0	0	0
C. Interiors	Interior Doors	0	0	0
C. Interiors	Finishes	0	0	0
C. Interiors	Fittings	0	0	0
D. Services	Lighting	0	0	0
D. Services	Thermal Comfort	0	0	0
Faculty Offices				
B. Shell	Windows	0	0	0
C. Interiors	Interior Doors	0	0	0
C. Interiors	Finishes	0	0	0
C. Interiors	Fittings	0	0	0
D. Services	Lighting	0	0	0
D. Services	Thermal Comfort	0	0	0
Public Spaces				
B. Shell	Windows	0	0	0
C. Interiors	Interior Doors	0	0	0
C. Interiors	Finishes	0	0	0
D. Services	Lighting	0	0	0
D. Services	Thermal Comfort	0	0	0
Student Offices				
B. Shell	Windows	0	0	0
C. Interiors	Interior Doors	0	0	0
C. Interiors	Finishes	0	0	0
C. Interiors	Fittings	0	0	0
D. Services	Lighting	0	0	0
D. Services	Thermal Comfort	0	0	0

Auditorium

B. Shell	Windows	0	0	0
C. Interiors	Interior Doors	0	0	0
C. Interiors	Finishes	0	0	0
C. Interiors	Fittings	0	0	0
D. Services	Lighting	0	0	0
D. Services	Thermal Comfort	0	0	0

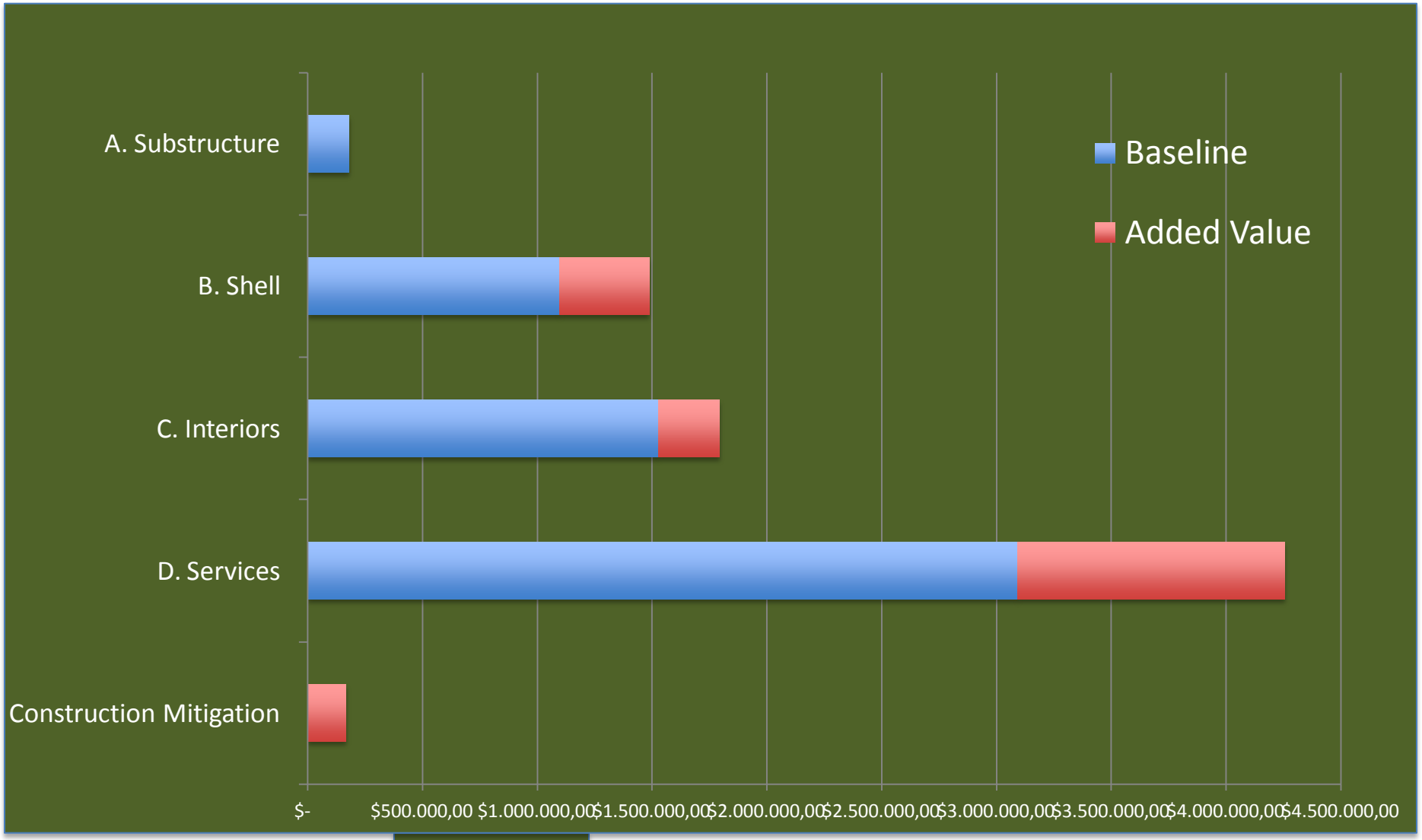
Target Costing

Developing Target Costs



Target Costing

Developing Target Costs



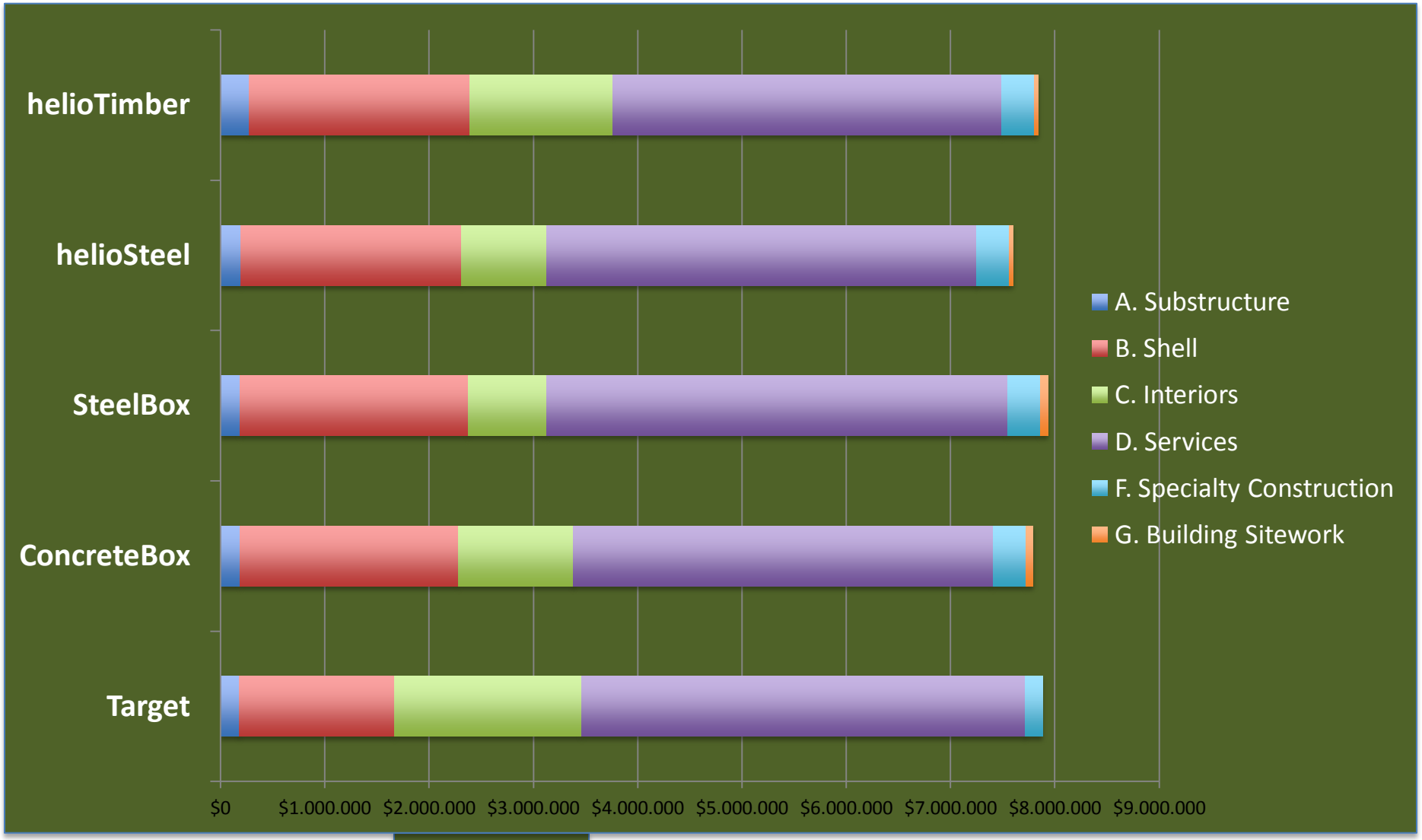
Target Costing

Developing Target Costs

	Estimate	Delta
Target	$7,880,000	$0
Green Box Concrete	$7,792,000	-$88,000
Green Box Steel	$7,933,000	$53,000
Helio Steel	$7,598,000	-$282,000
Helio Timber	$7,840,000	-$40,000

Target Costing

Final Estimates

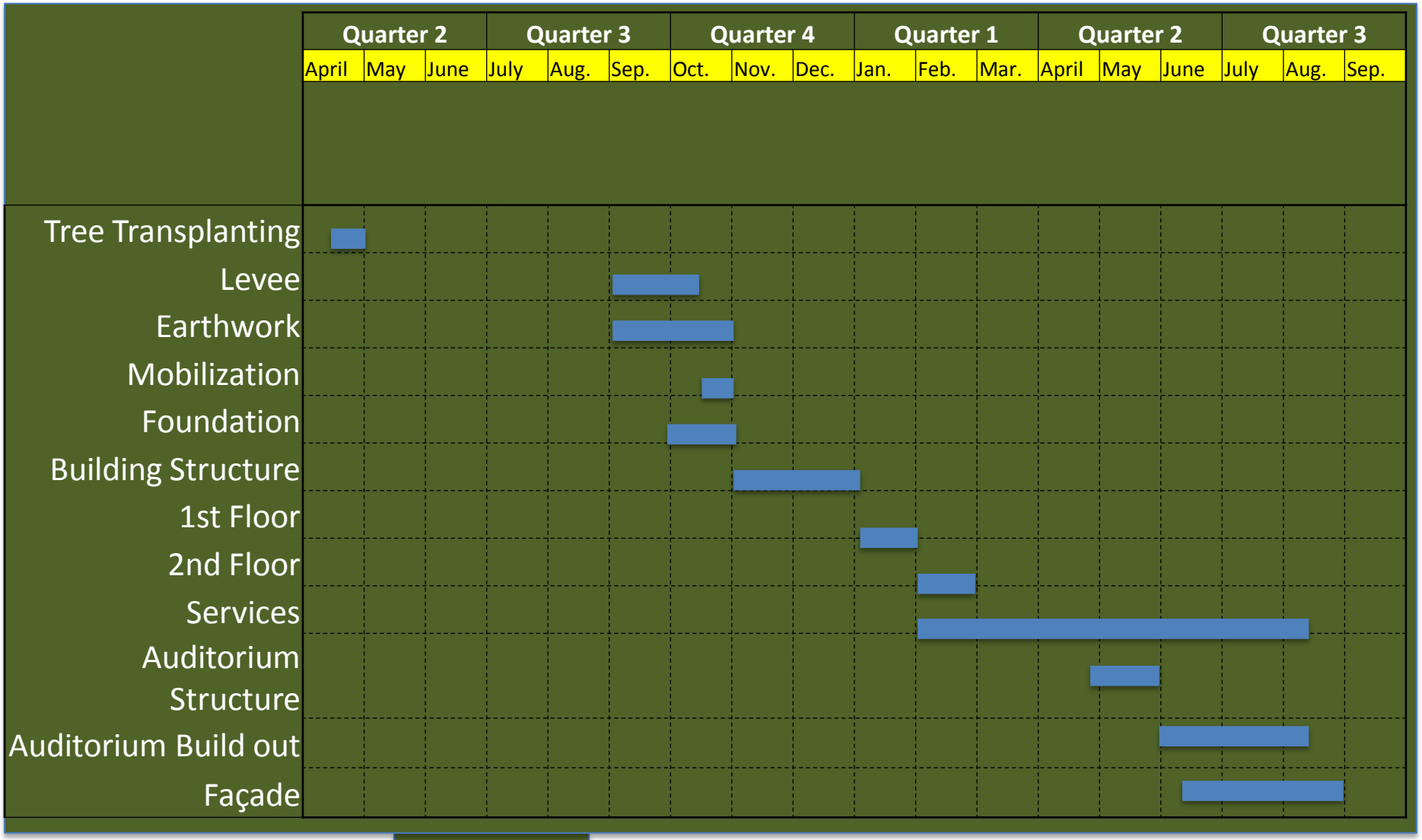


Construction

Schedule – Green Box Steel

Construction

Schedule – Green Box Concrete

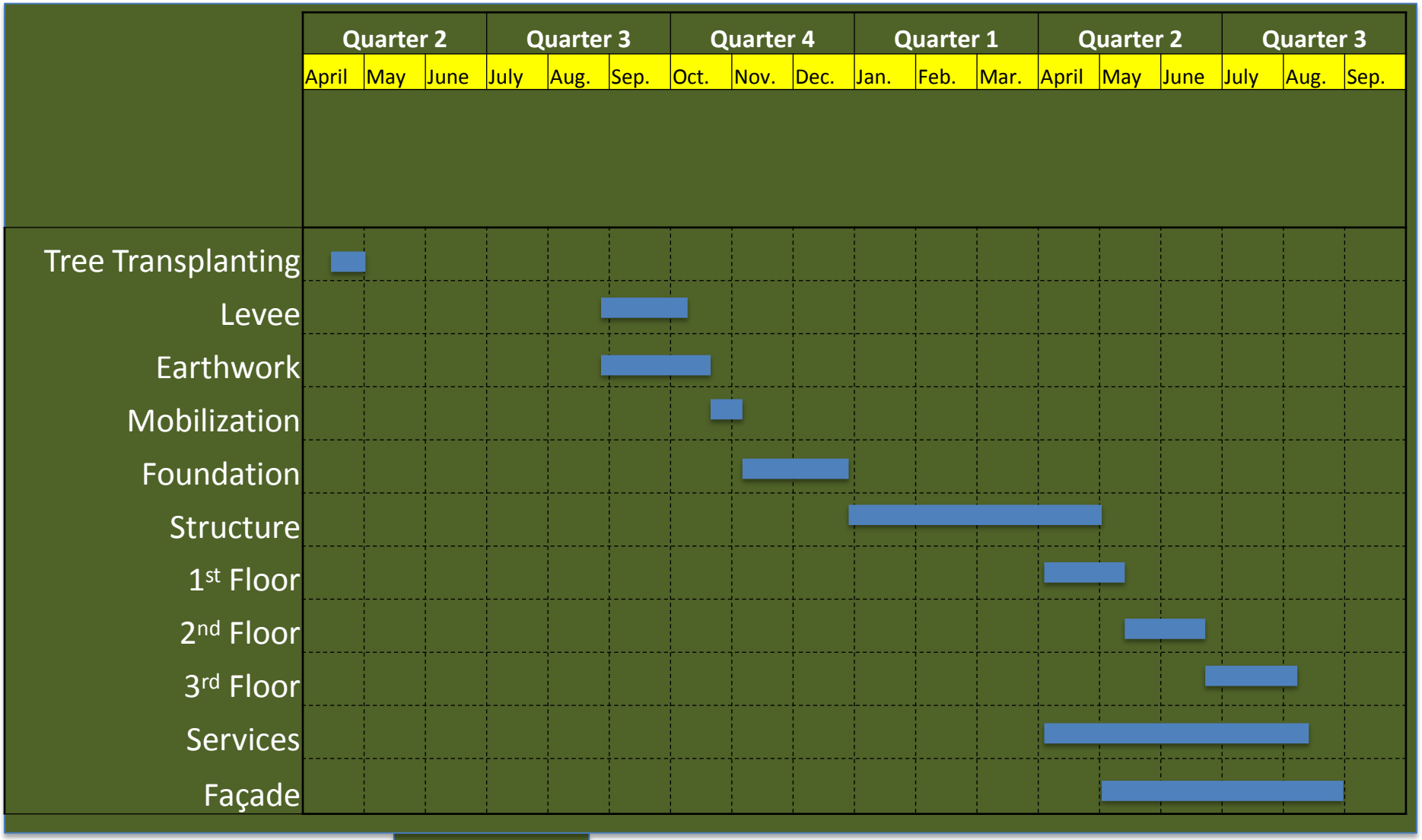


Construction

Schedule – Helio Steel

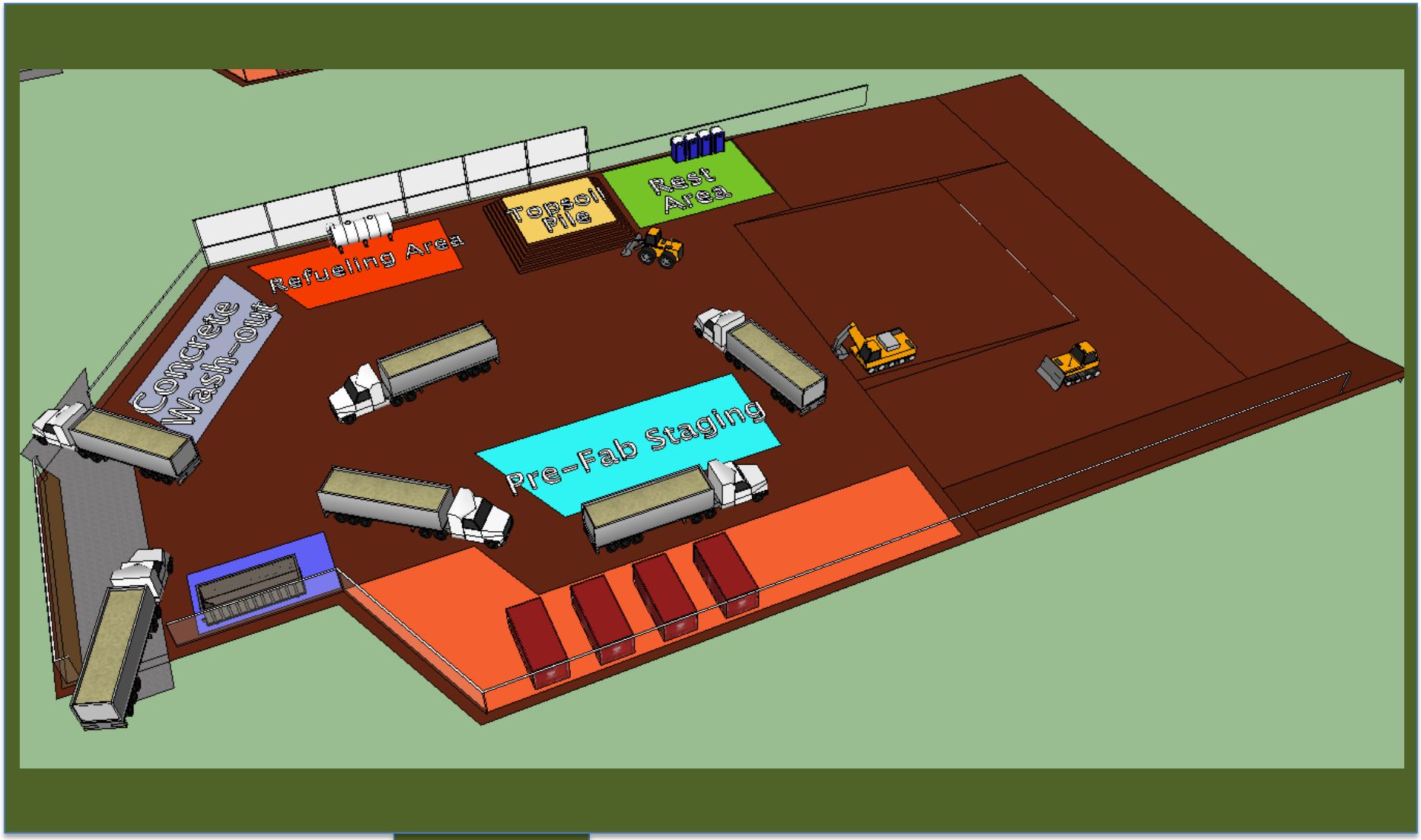
Construction

Schedule – Helio Timber



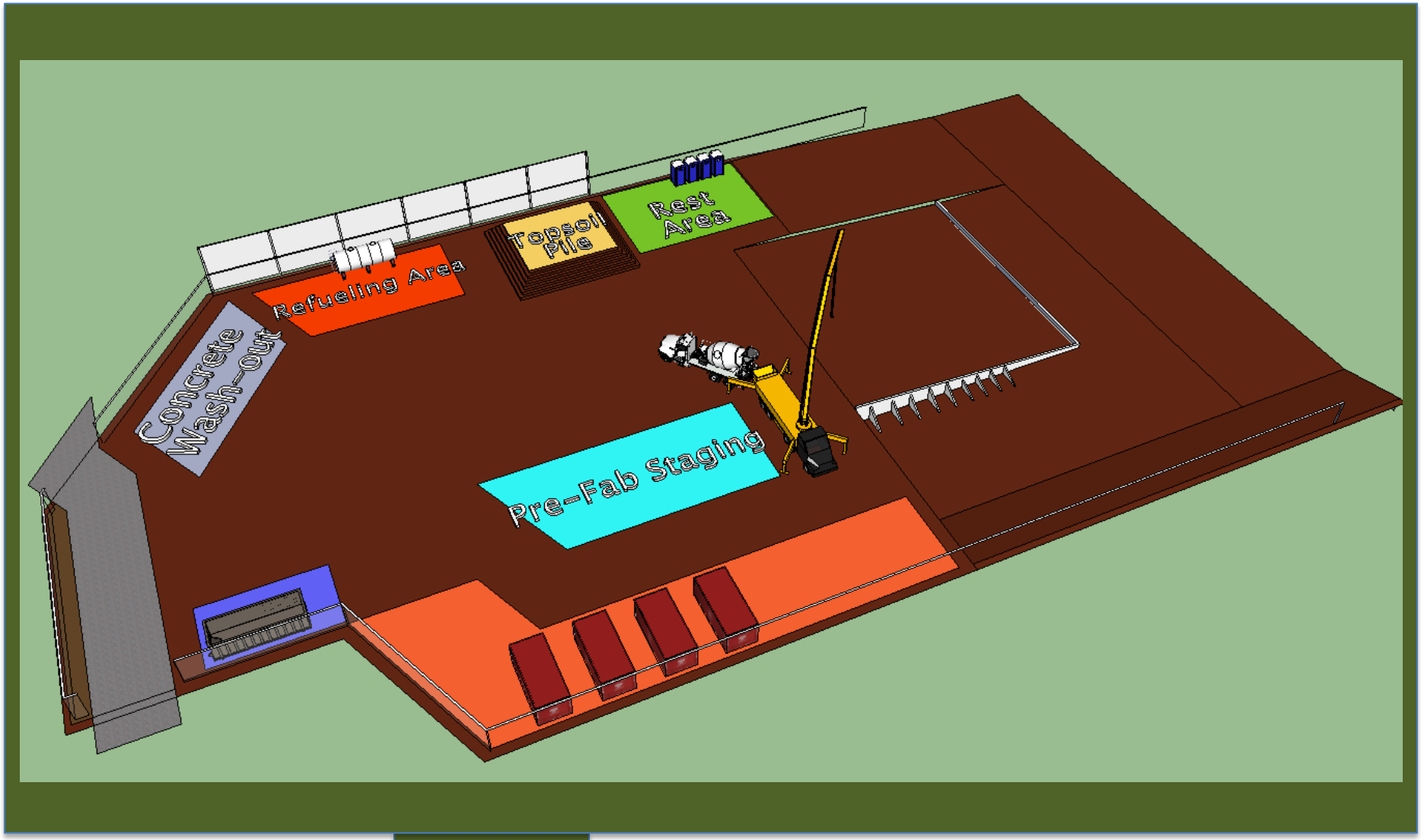
Construction Visualization

Excavation Phase



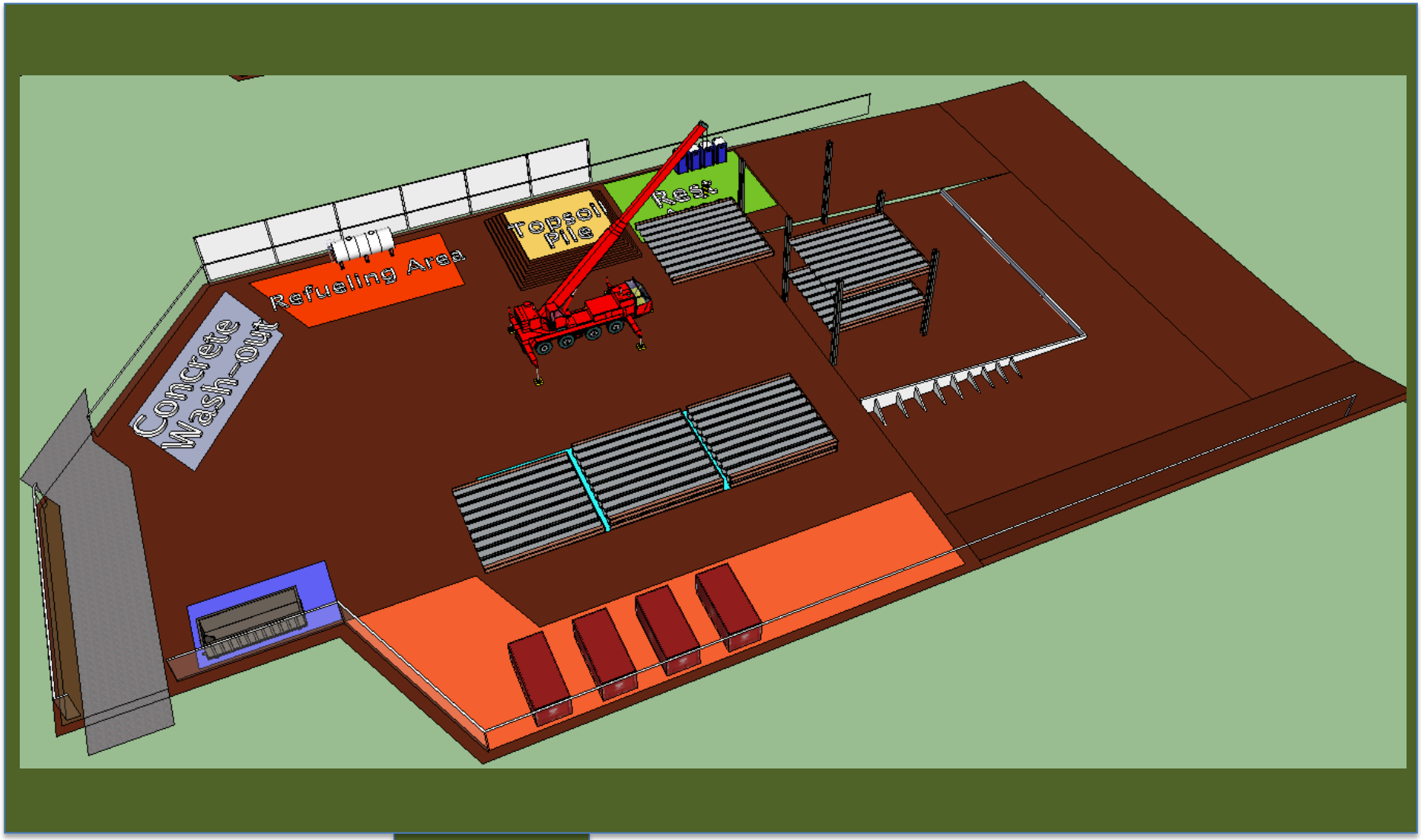
Construction Visualization

Foundation Phase



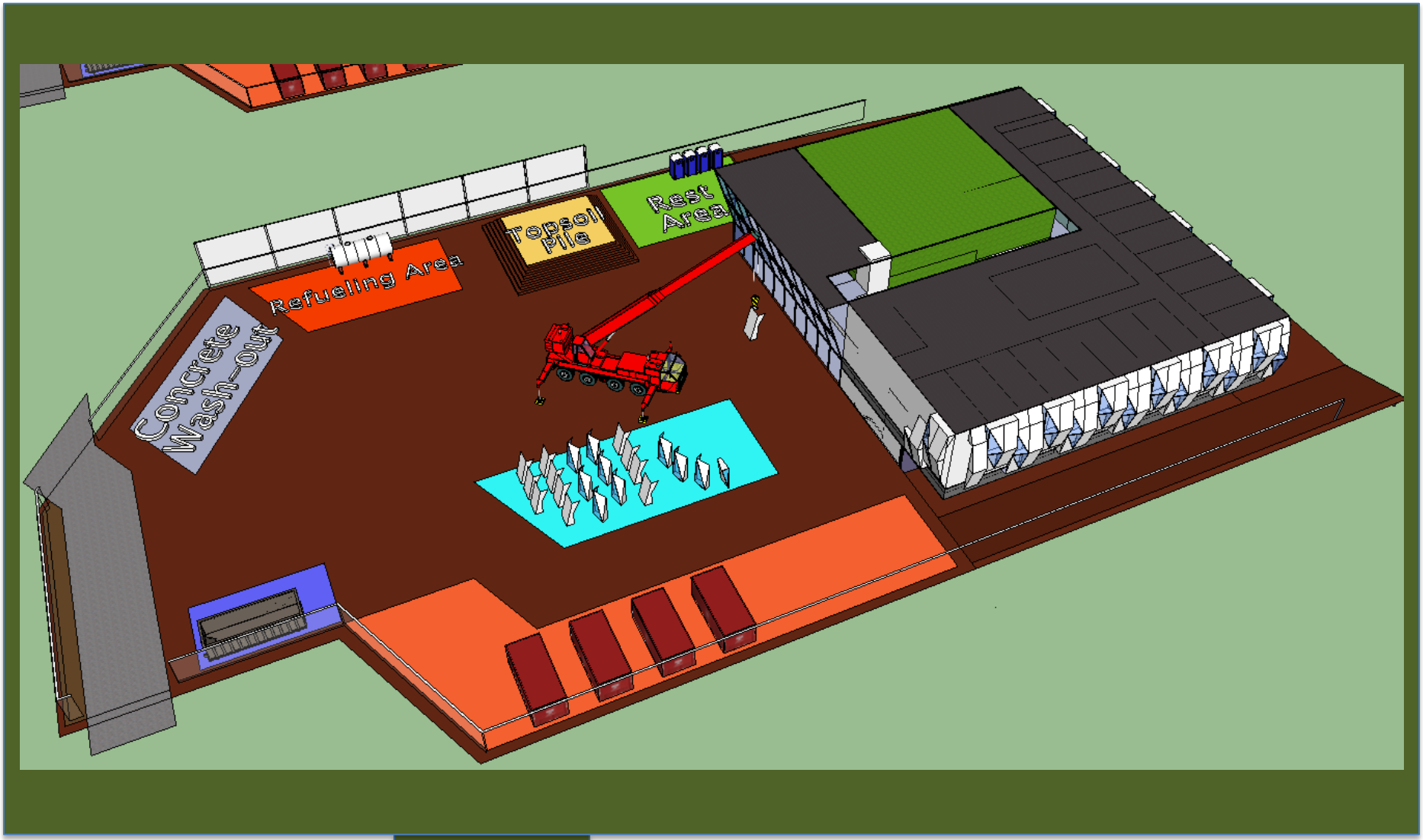
Construction Visualization

Prefabricated Structure Phase



Construction Visualization

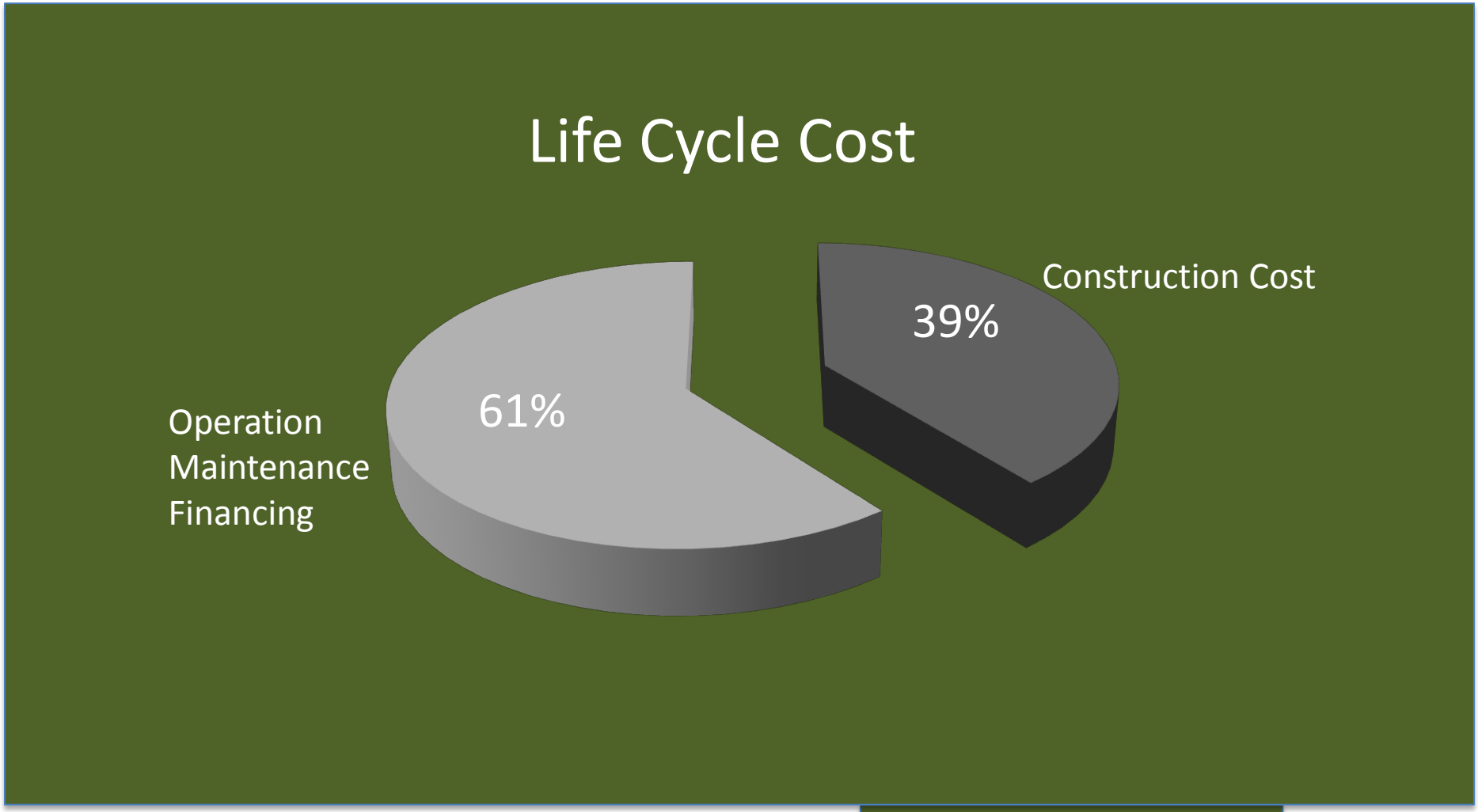
Prefabricated Cladding Phase



Life Cycle Financial Management

Team Member

Maria



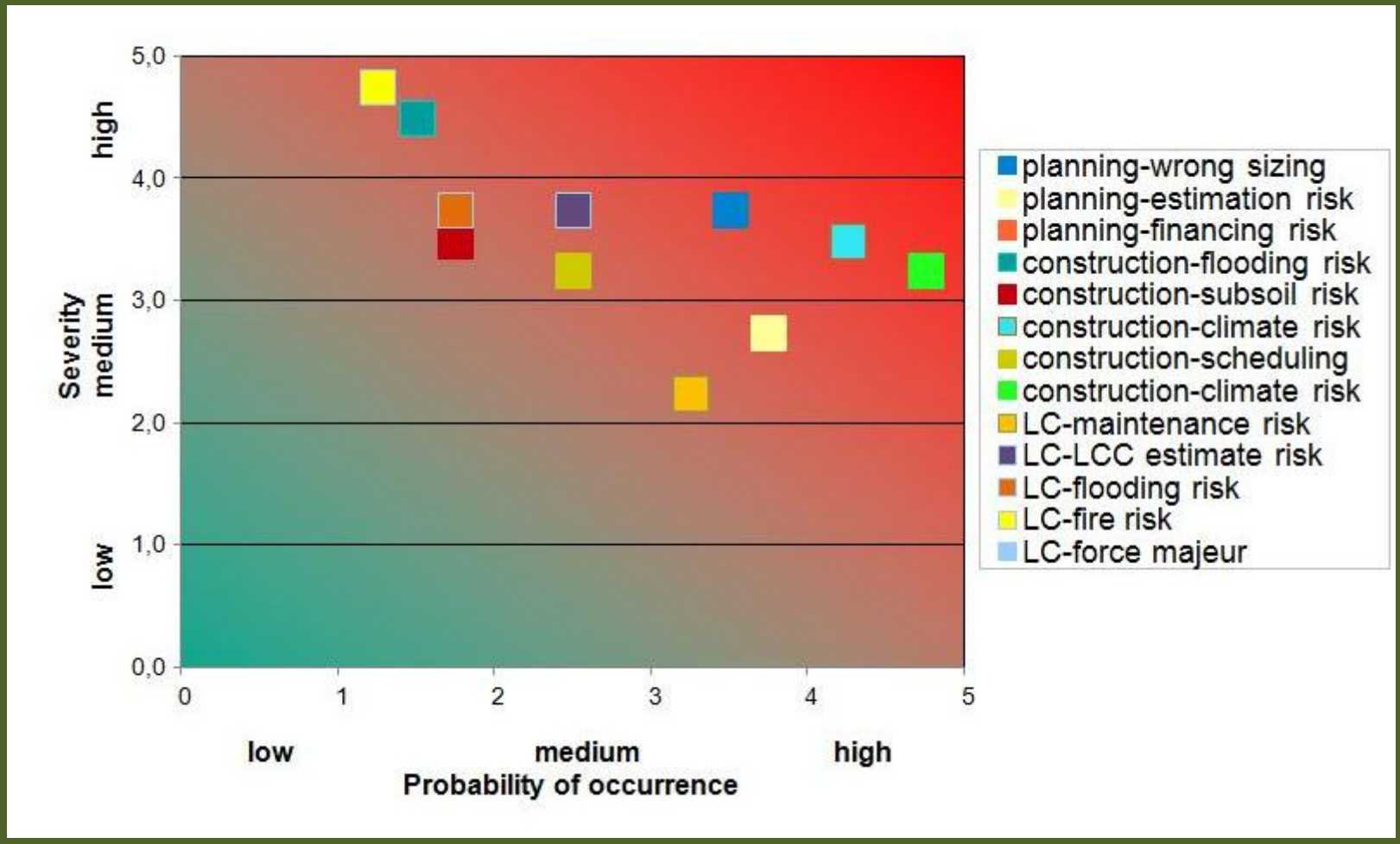
Risk Identification

Identification, allocation, evaluation of risks

	Risk name	Description	Consequences	Risk Allocation		Responsibility	Risk Management	risk probability	damage
				Contractor	Owner				
	Planning phase								
1	wrong sizing	wrong sizing (windows, doors, columns...)	problems to fulfill the time schedule -> increasing costs	X		A, E			
2	requirement risk	incorrectly predicted user requirements (quantity, quality, functionality,...)	additional costs, possibly time delay -> increasing costs		X		good comunication with engineers, very careful planning	2	3
3	Financing risk	capital for intermediate or long-term financing cannot/not on the planned terms be applied	Risk for whole project, scheduling risk	X	X	all	requirements fixed in contract, good documentation, owner integration	1	2
4	permission risk	permission takes longer than expected	problems to fulfill the time schedule -> increasing costs	X			detailled finance structure, good documentation	1	4
5	legal risk and changing of standards	revise planning/calculations	problems to fulfill the time schedule -> increasing costs		X		good comunication within team, go for partial permissions, stay in contact with authorities	2	2
6	wrong cost estimation	uncertainty of future prices	budget explotion	X			good documentation, forecasting	1	2
7	date delay	bad schedule for hand-ins of plans	time delay, more costs	X	X		close look at past price development and current trends, security deposit	2	2
							updating on dead lines, restrictions for late entry	1	2

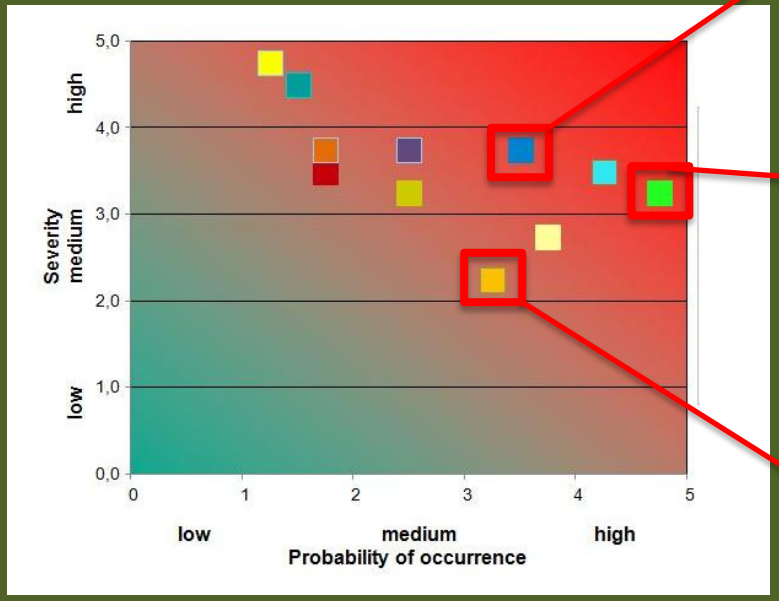
Risk Identification

Major risk aspects



Risk Treatment

Major risk aspects



Wrong sizing risk (planning):
-communication and collaboration

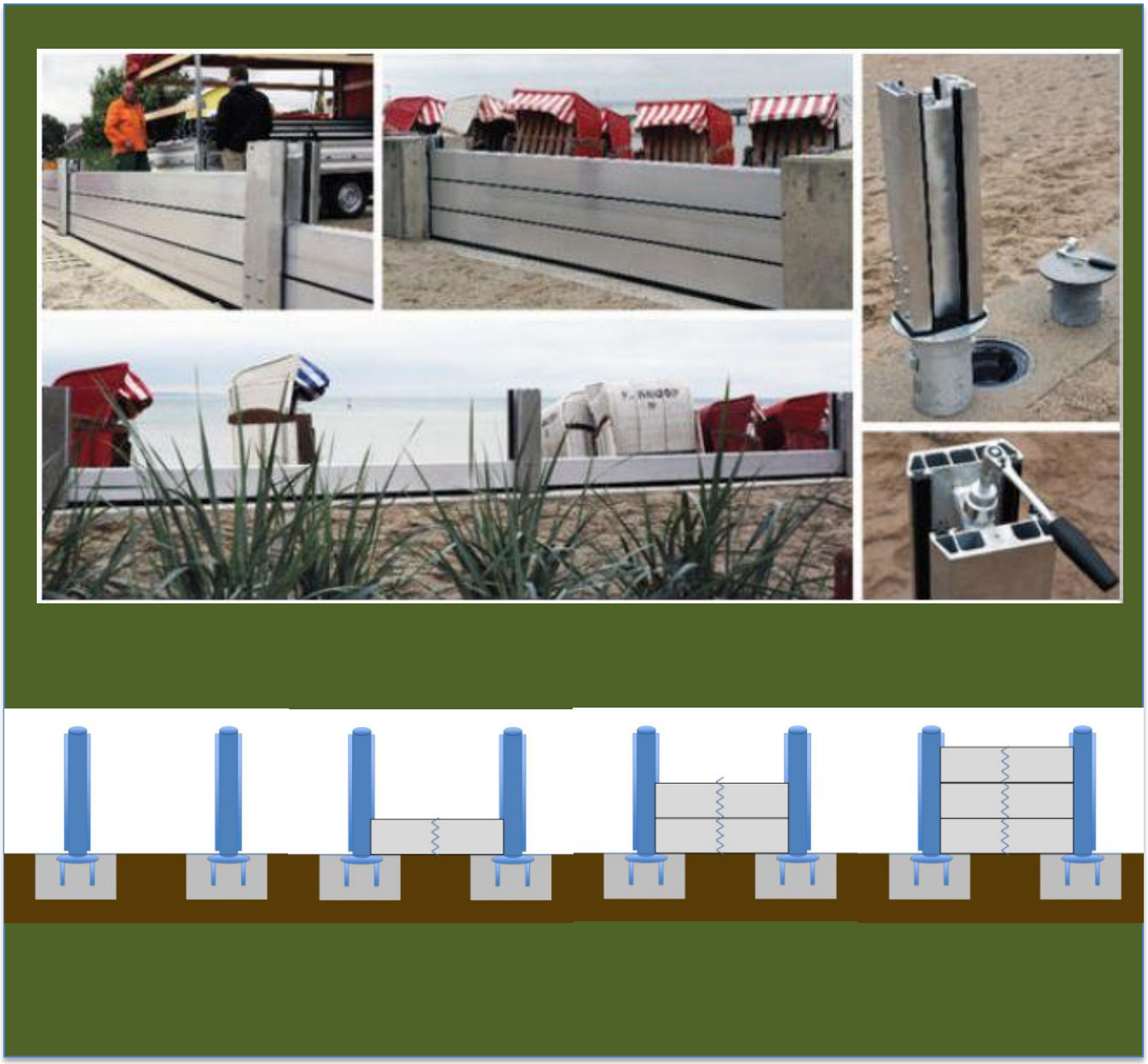
Climate risk (construction):
- Buffer in schedule
- schedule for bad weather

Maintenance risk (O&M):
- High quality equipment/materials
- maintenance plan

Risk Treatment

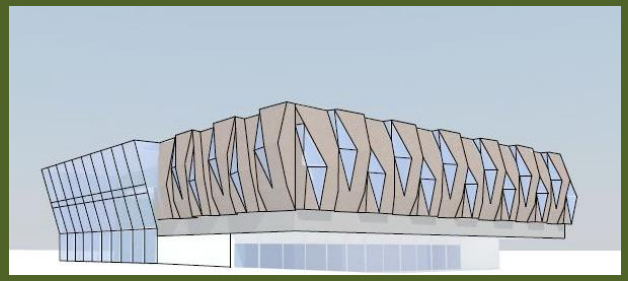
Flooding Risk

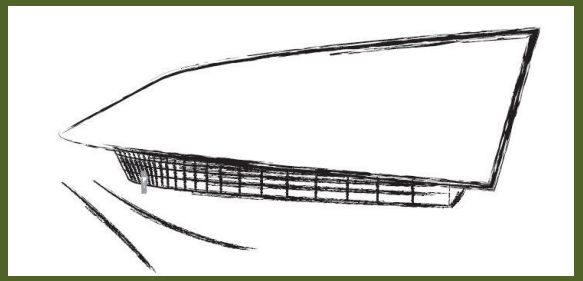
- temporary levee construction
- storable
- small modular components
- Cost 253.000€
- risk cost 360.000 €



Operation and Maintenance

Comparison of monthly Operation and Maintenance cost

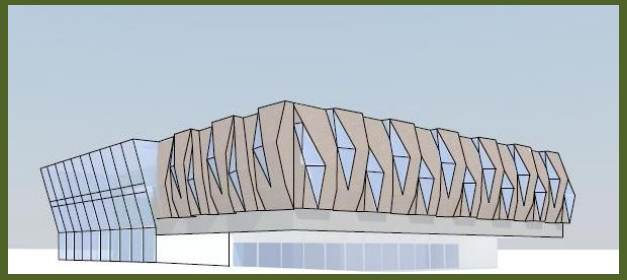


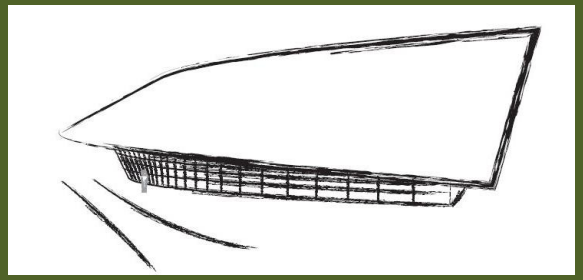


Per month	Green Box- Steel	Green Box- Concrete	Heliotropism-steel	Heliotropism- Wood
cleaning	23.179 €	23.293 €	25.468 €	27.471 €
energy	0 €	0 €	0 €	0 €
other supplies	24.270 €	23.698 €	27.132 €	29.421 €
Operation	47.449 €	46.991 €	52.600 €	56.892 €
Maintenance	42.106 €	40.676 €	49.424 €	54.575 €
Replacement	94.914 €	93.714 €	104.752 €	103.132 €
Operation & Maintenance	185.000€	182.000€	207.000€	215.000€

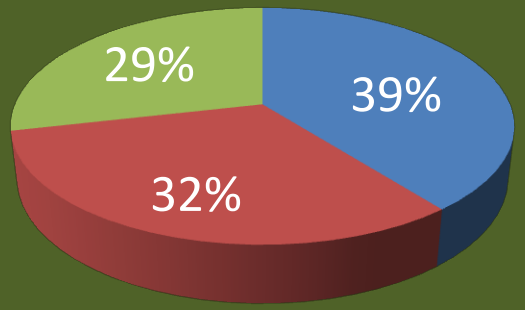
Life Cycle Cost

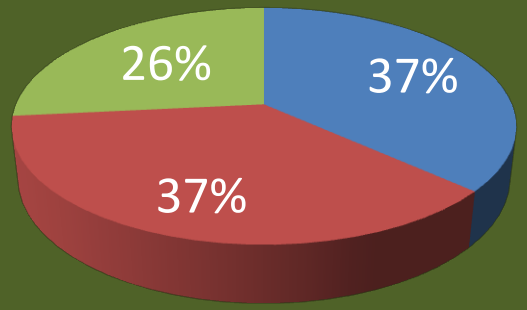
Comparison of Life Cycle Costs over 25 years





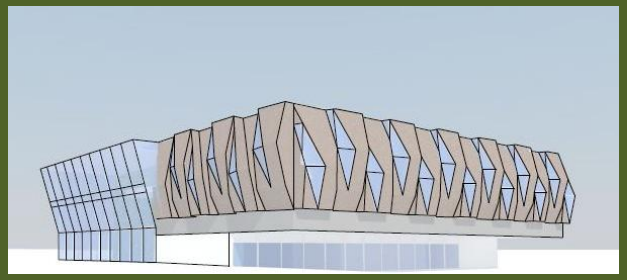
	Green Box- Steel	Green Box- Concrete	Heliotropism-steel	Heliotropism- Wood
Construction cost	6.364.000 €	6.278.000 €	6.413.000 €	6.054.000 €
O & M cost	5.187.000 €	5.097.000 €	5.825.000 €	6.082.000 €
Financing cost	4.617.000 €	4.554.000 €	4.653.000 €	4.392.000 €
Life Cycle Cost	16.168.000€	15.929.000€	16.891.000€	16.528.000€

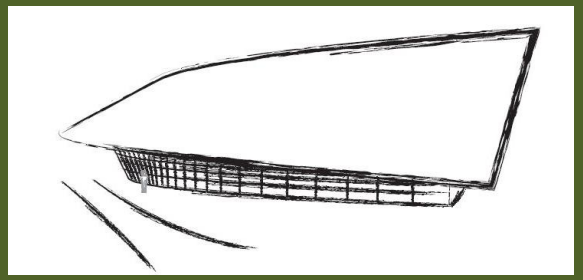




Rent

Total first year rent



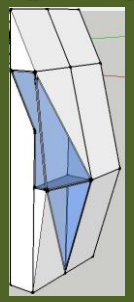


	Green Box- Steel	Green Box- Concrete	Heliotropism-steel	Heliotropism- Wood
rent first year	650.000€	640.000€	676.000€	657.000€

Target value in Operation & Maintenance

Minimizing the Rent

Expenses – extra income = RENT



Minimizing expenses

- construction cost
  - modular elements
- operation & maintenance
  - net zero
  - bio-wall
- financing
  - financial engineering

Maximizing income

- Café
  - size, location
- rent Auditorium
  - accessibility

LEED Evaluation

Gold and aiming for platinum

LEED Gold (71 points)

Innovation points:
- net –zero
- design of biowall
- 95% construction waste diversion

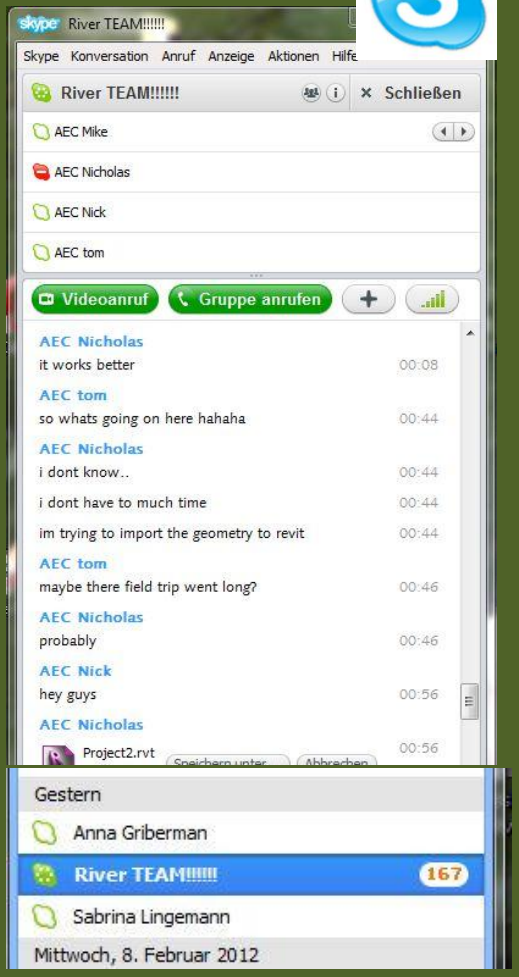
Aiming Platinum:
- storm water design
- water use reduction
- landscaping
- Measurement & Verification plans

Team Process

technologies

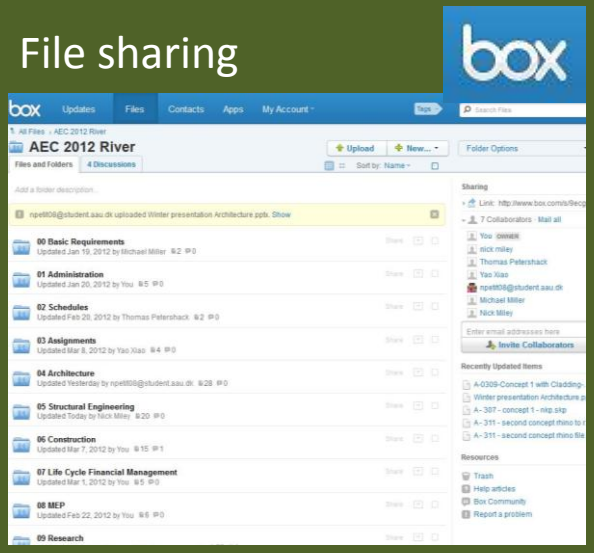
announcements

Conversation

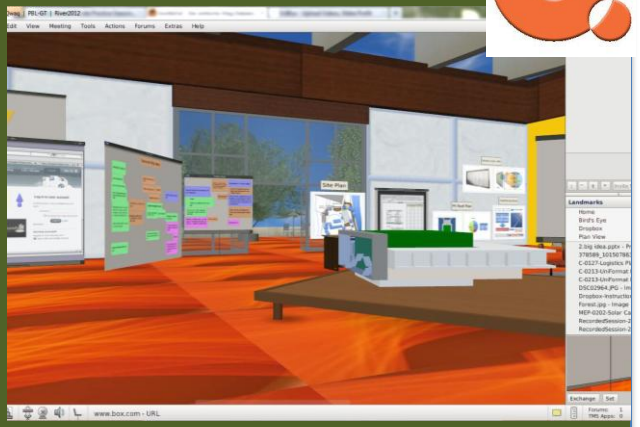


Regular Team meetings

File sharing



Team meetings



architecture structure construction mep life cycle financial management

Team process

Meeting organization

Meeting agenda

box

Meeting Minutes **January 22nd, 2012**

Name	E-mail	Role
Yao Xiao	yxiao1988@gmail.com	Structural Engineer
Maria Frank	mara_frank@web.de	LCFM
Nick Miley	nemiley@stanford.edu	Structural Engineer
Mike Miller	mike.s.miller44@gmail.com	Facilitator, CM
Nicholas Petitmaire	Nicholas.petitmaire@gmail.com	
Tommy Petershack	Tpetershack@wisc.edu	Structural Engineer

I. Meeting Agenda 2min
II. Intro Communication 10min
III. Architecture 25min
IV. MEP 10min
V. Construction 10min
VI. Structural 10min
VII. Life Cycle Analysis 10min
VIII. Organization 5min
IX. Assignments – Action items 10min
X. Upcoming Deliverables 5min
XI. Next Meeting

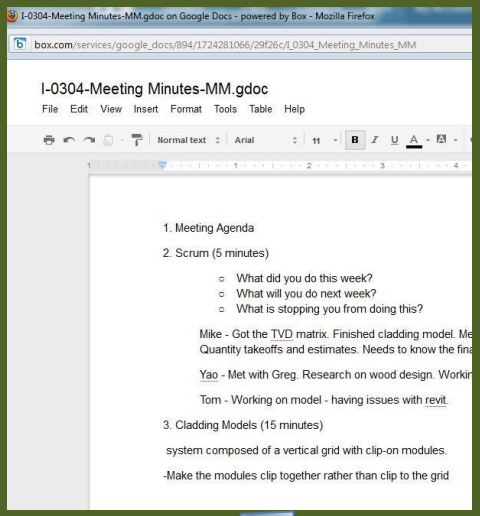
meetings

GoToMeeting™

Weekly role rotation

Meeting Date	Facilitator	Recorder
~~1/22/2012~~	~~Mike~~	~~Nick~~
1/29/2012	Maria	Yao
2/5/2012	Nick	Tom
2/12/2012	Yao	Nicholas
2/19/2012	Tom	Mike
2/26/2012	Nicholas	Maria
3/4/2012	Mike	Nick
3/11/2012	Maria	Yao

real time Meeting minutes

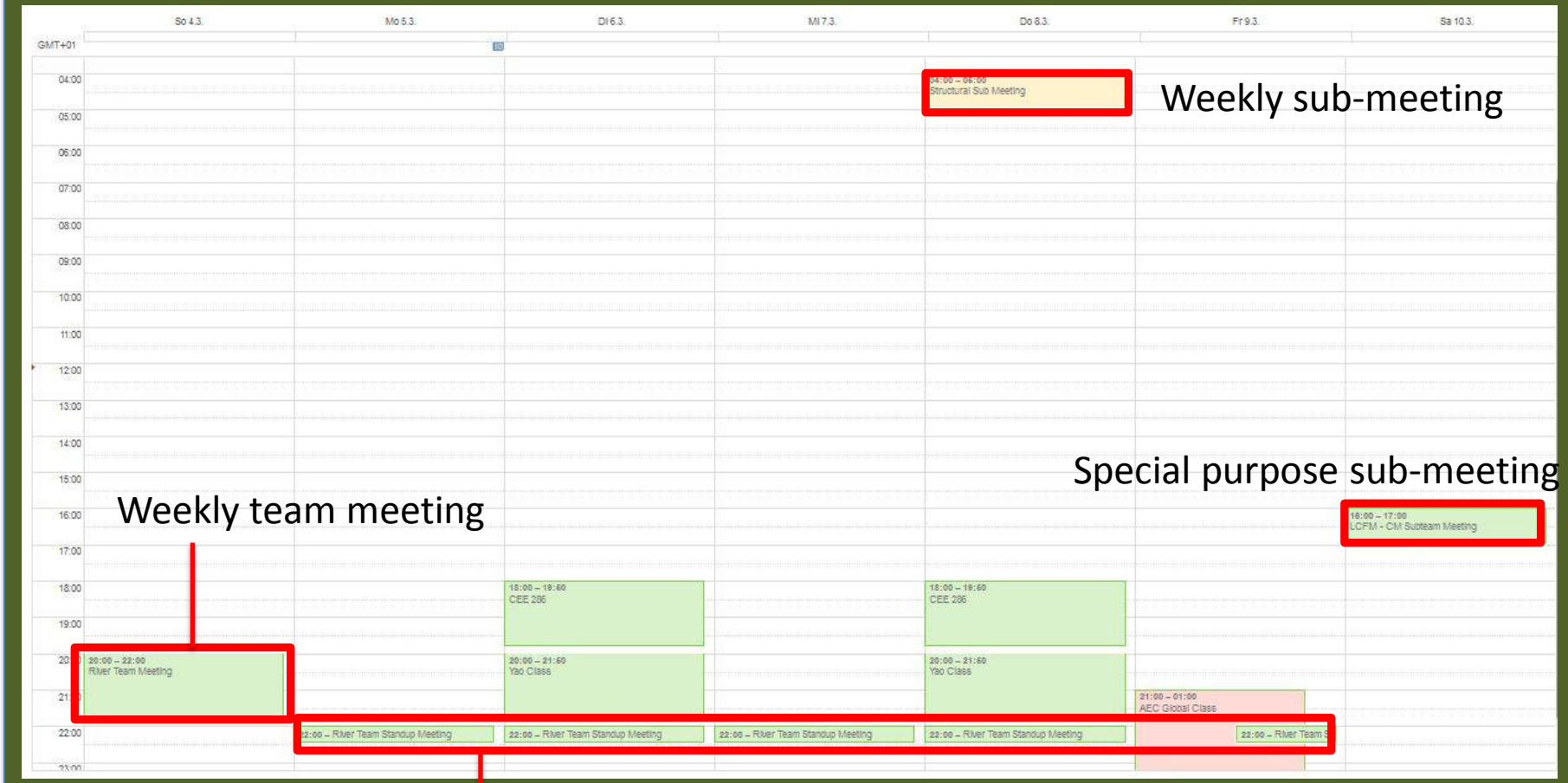


Setting new tasks

I-0115-TaskList-All.gsheet
V11 Updated Mar 8, 2012 by

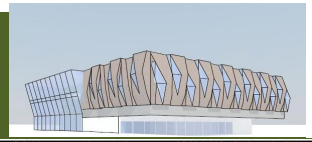
Team process

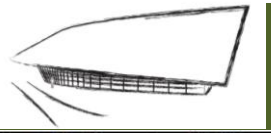
Meeting schedules



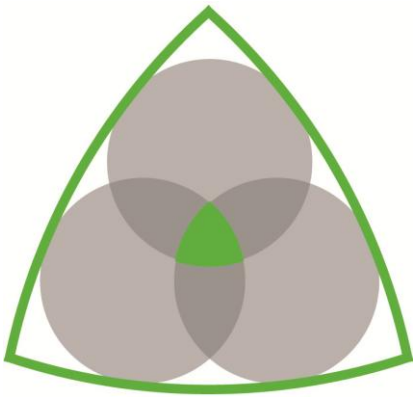
Maximizing the Triple Bottom Line

Decision Matrix



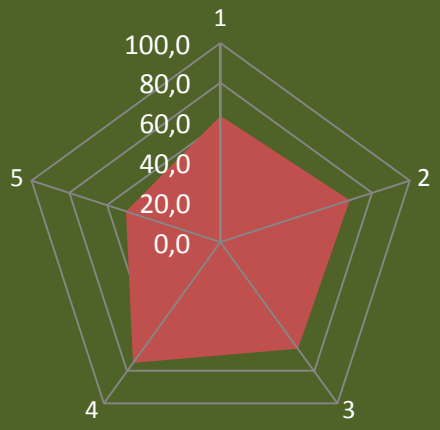


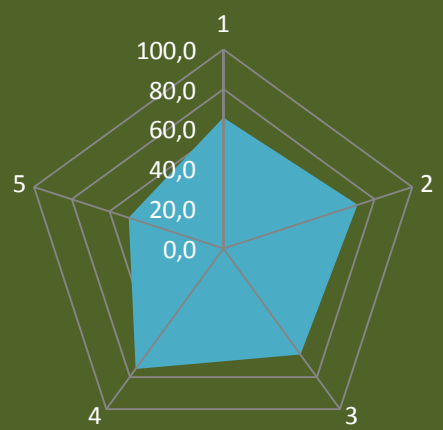
GOALS	SUBGOALS	ASPECTS	SUBASPECTS	STEEL	CONCRETE	STEEL	WOOD
Economical			33,00%	63,7	63,5	52,7	53,2
	NFA/GFA		20,00%	76	71	60	55
		max. ass. Area	50,00%	90	80	50	40
		efficient organization	40,00%	70	70	70	70
		Utilization of roof area	10,00%	30	30	70	70
	Structure performance		15,00%	72,5	72,5	50	57,5
		Regular grid	50,00%	90	90	30	30
		efficient structure	25,00%	90	80	70	70
		Complexity of structure	25,00%	20	30	70	100
	Construction Cost		20,00%	30	30	20	40
	Constructability		15,00%	62	58	65,5	46,5
		Manageable delivery	45,00%	40	80	60	30
		Short schedule	55,00%	80	40	70	60
	Maintenance cost		30,00%	74,5	79	64,5	62
		Low replacement cost	25,00%	70	70	50	50
		Operation cost	25,00%	80	90	80	70
		Operation ease	10,00%	70	70	60	50
		Minimizing risk	10,00%	60	80	50	60
		Extra income	10,00%	80	80	70	70
		Energy cost	20,00%	80	80	70	70
Ecological			34,00%	71,0	68,3	72,2	72,8
	Quality of spaces		15,00%	83	83	83,5	83,5
		Quality of outdoor space	35,00%	70	70	90	90
		Quality of indoor space	65,00%	90	90	80	80
	choice of material		15,00%	70	52	70	74
		recycled material	20,00%	70	60	70	50
		Life cycle of materials	80,00%	70	50	70	80
	Energy efficency		40,00%	75	75	78	78
		Renewable energy	40,00%	90	90	90	90
		Natural ventilation	30,00%	70	70	80	80
		Natural daylight	30,00%	60	60	60	60
	Waste		30,00%	60	60	60	60
Social goals			33,00%	66,0	66,2	76,4	81,8
	Atmosphere		25,00%	50	50	76	91
		Design	30,00%	40	40	80	90
		Park view	30,00%	60	60	80	80
		Innovation	40,00%	50	50	70	100
	Educational Integration		20,00%	70	66	82	90
		Student/Teacher	60,00%	70	70	90	90
		Using building as	40,00%	70	60	70	90
	Local ressources		20,00%	75	80	75	75
		local labor	50,00%	80	80	80	70
		local material	50,00%	70	80	70	80
	Involvement of public		25,00%	70	70	80	80
	Representation		10,00%	70	70	60	60
			Total	66,9	66,0	67,2	69,3

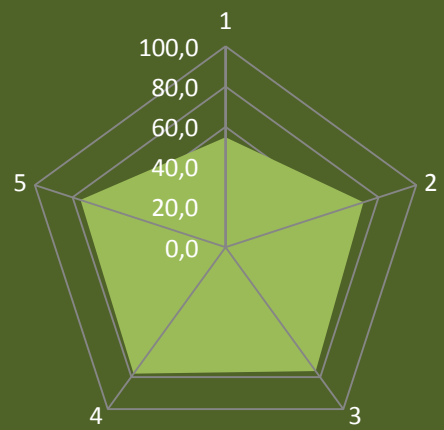


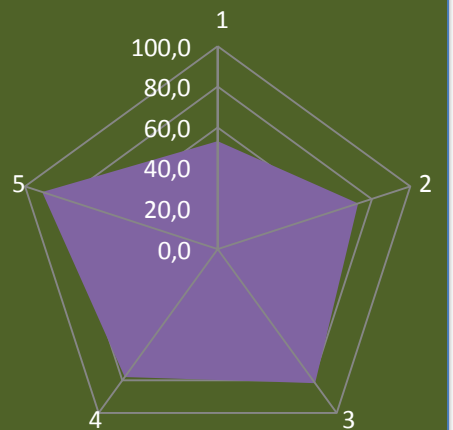
Maximizing the Triple Bottom Line

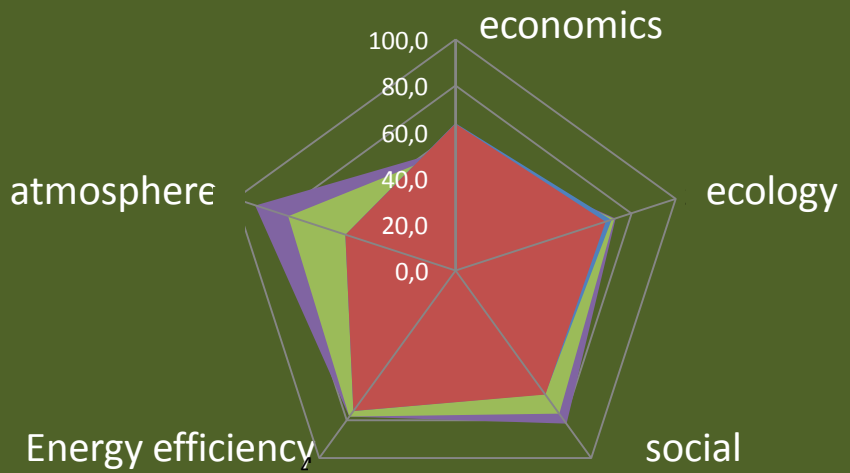
Identification, allocation, evaluation of risks





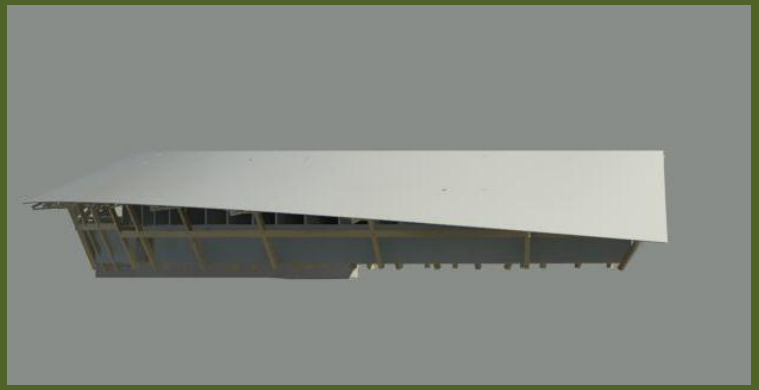






And the winner is….

Heliotropism timber construction



Thank you

Owners: Forest and Dave
ARUP: Kyle and Afaan
University of Wisconsin: John Nelson
GPLA: Greg Luth
Degenkolb: Erik Kneer
DPR: Dan Gonzales
capgemini: Mathias Ehrlich
Bauhaus-University Weimar: Björn Wündsch

QUESTIONS ???