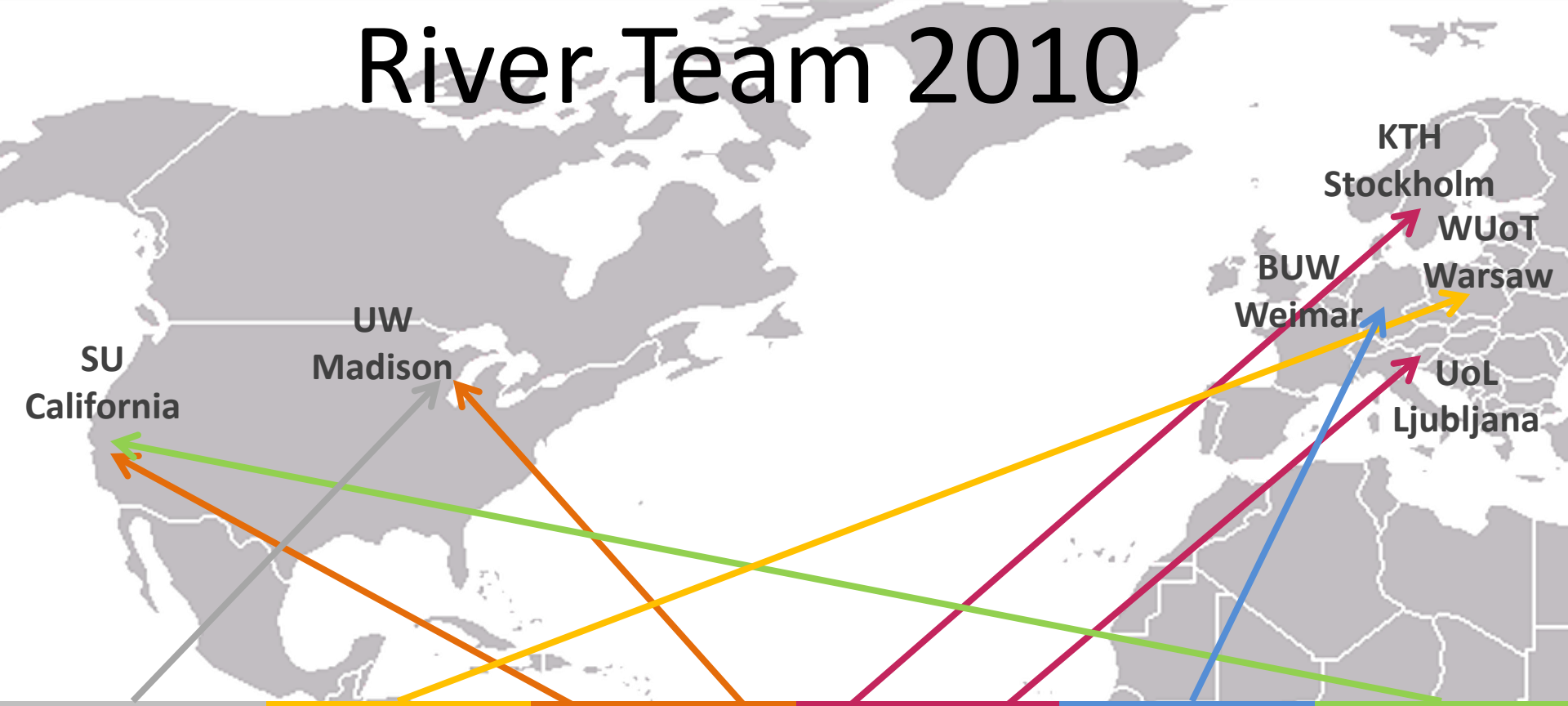
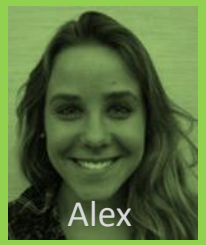
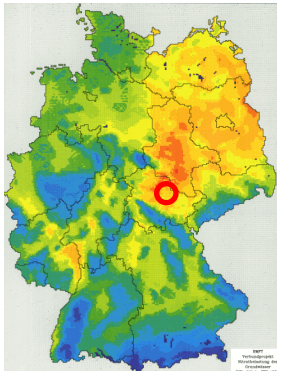
River Team 2010



Owner	A	E	C	L	S
 David	 Urszula	 Joanna  Brent	 Nima  Martin	 Sebastian	 Alex

Site Conditions

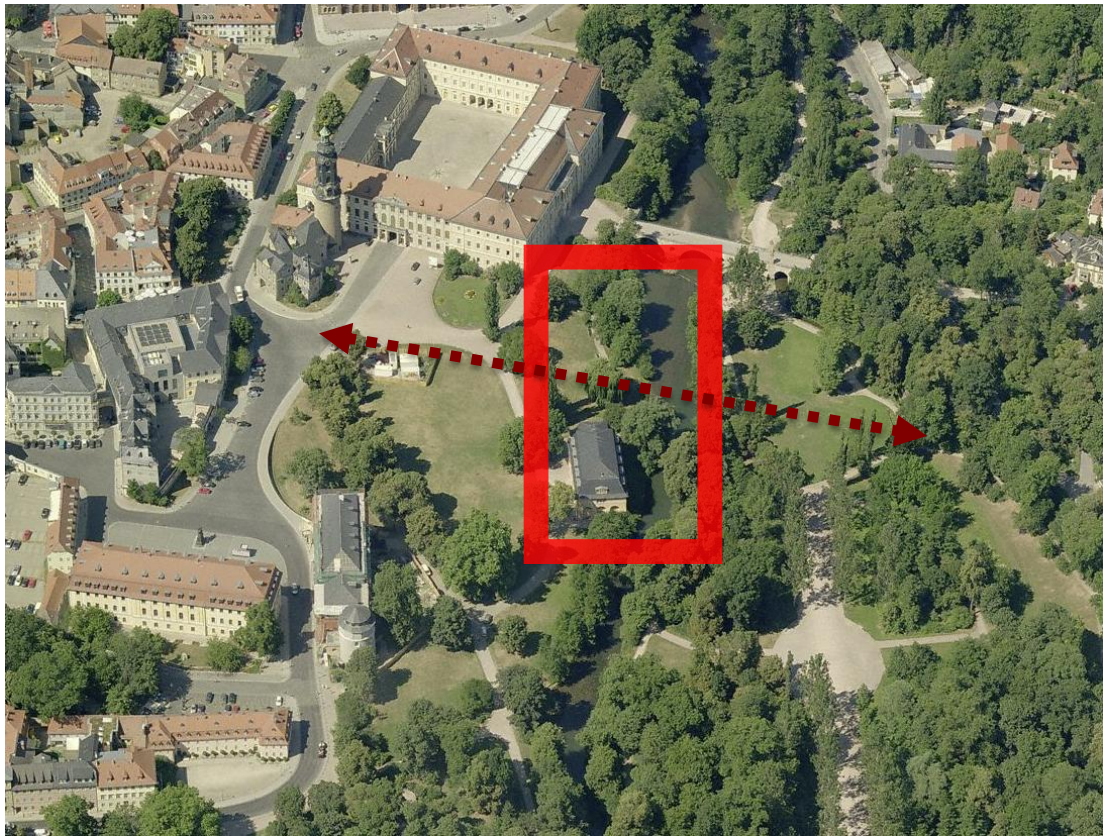
University building in Weimar, Germany



Main aspects:

- Flooding (river)
- Climate (+/-)
- City/nature
- Old Town, Castle

Monat	Temp. max.	Temp. min.	Sun hours	Rain days
Januar	2,4 °C	-3,0 °C	1,6 h	17 d
Februar	2,8 °C	-3,7 °C	2,5 h	15 d
März	8,1 °C	-0,7 °C	3,6 h	13 d
April	13,2 °C	3,3 °C	4,9 h	14 d
Mai	18,2 °C	7,5 °C	6,8 h	14 d
Juni	21,4 °C	10,9 °C	7,1 h	13 d
Juli	23,0 °C	12,7 °C	6,9 h	14 d
August	22,7 °C	12,3 °C	6,3 h	13 d
September	19,4 °C	9,4 °C	4,7 h	13 d
Oktober	13,1 °C	5,1 °C	3,2 h	14 d
November	7,1 °C	1,7 °C	1,7 h	15 d
Dezember	3,1 °C	-2,1 °C	1,4 h	15 d



A

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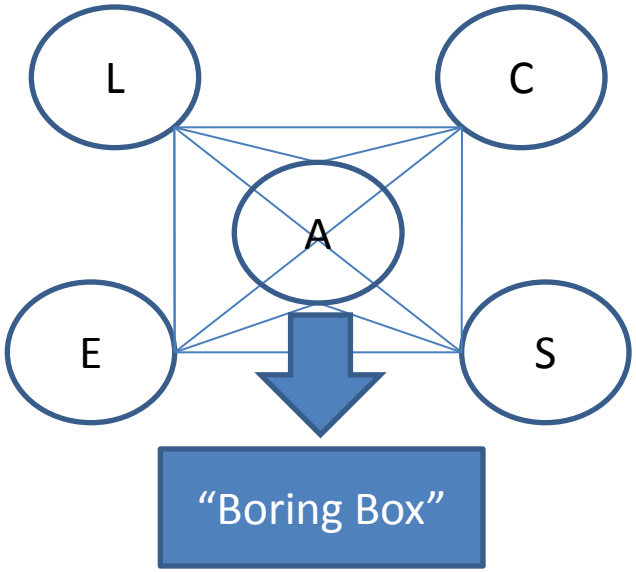
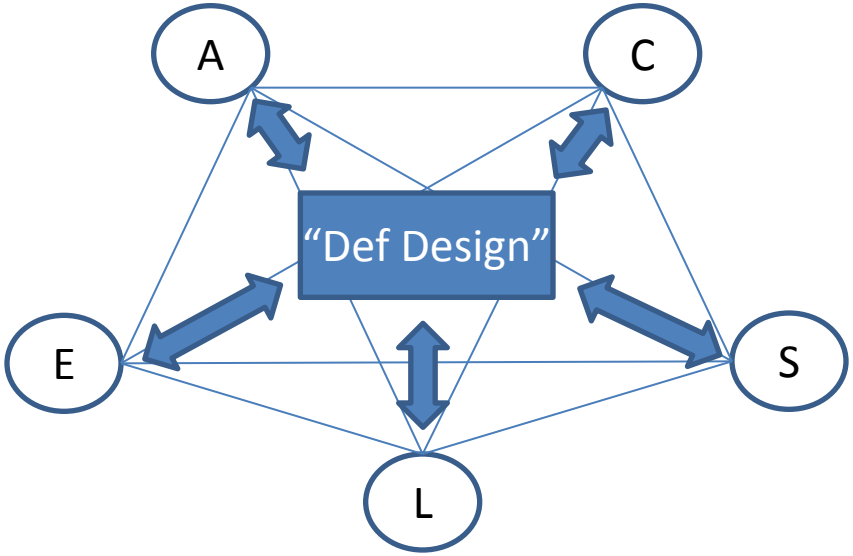
Cooperation Process

"Transparency" idea



"ReUse" idea

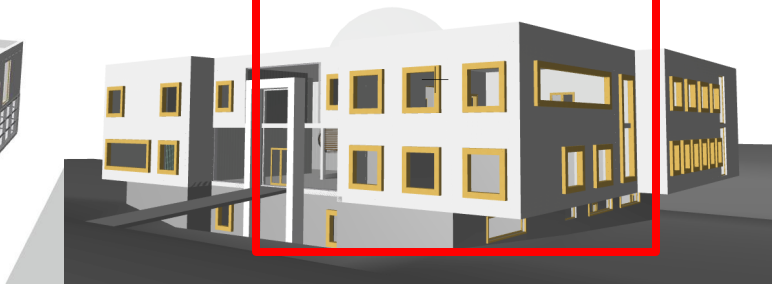


A
E
C
L
S

Decision Matrix

Rating: 1 low - 5 high

	TRANSPARENCY		REUSE	
aspect	concrete	steel	concrete	steel
Program fulfill	4	4	2	2
Response to the context	3	3	5	5
Big idea	2	2	4	4
Innovation	3	3	4	4
Floor to ceiling height	4	2	3	5
Cantiliver support	2	4	3	5
Lateral System	4	2	5	3
Connections	3	5	3	4
Construction costs	3	1	4	2
Constructability	2	4	3	5
Construction schedule	4	5	4	5
Prefabrication	1	4	2	5
Flexibility of spaces	4	5	3	2
Space efficiency	3	3	4	4
Flood prevention	2	2	4	4
Sustainability	2	2	4	4
Future design potentials	3	3	5	5
sum	49	54	62	68



A

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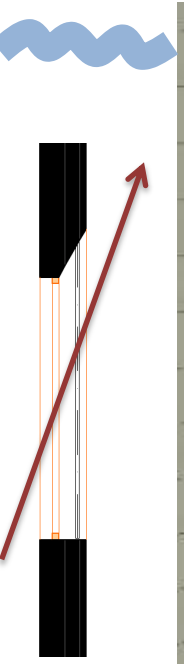


A

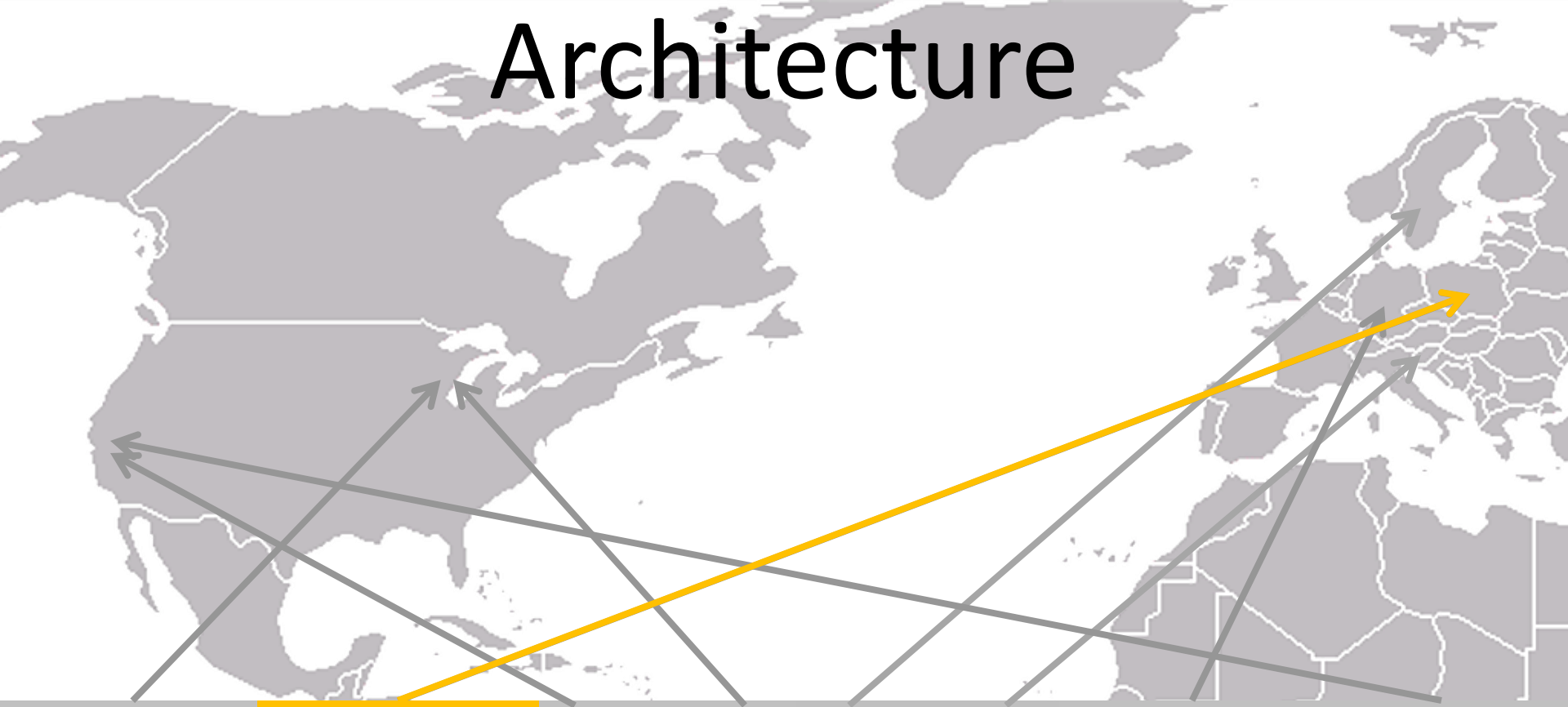
E

C

L

S

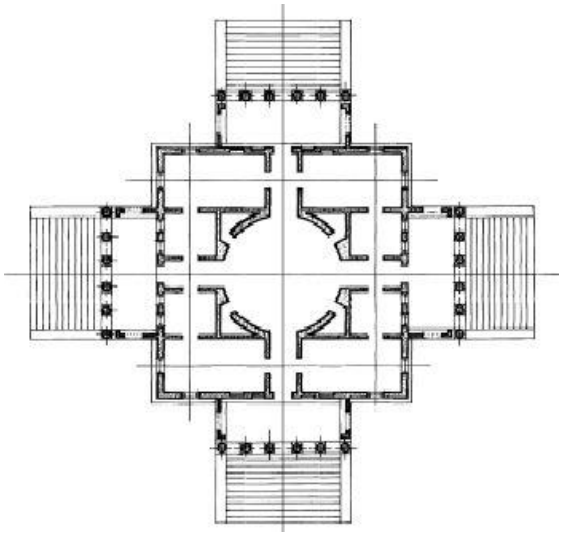
Architecture



Owner	A	E	C	L	S
David	Urszula	Joanna, Brent	Nima, Martin	Sebastian	Alex

Historic

Owner's wish



Harmony

Proportions

Symmetry

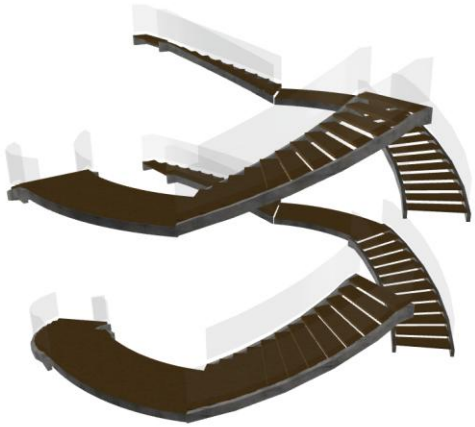
ReUse

Big Idea

- reusing **historical style**
- reusing **old materials**
- reusing **water**
- "reusing" **sunlight**
- reusing **rooms**

Spiral

Core Area



- Iconic place
- Vertical circulation
- Integration area
- Visually attractive
- Building identity
- SE challenging :D

A

E

C

L

S

Riverside view

A

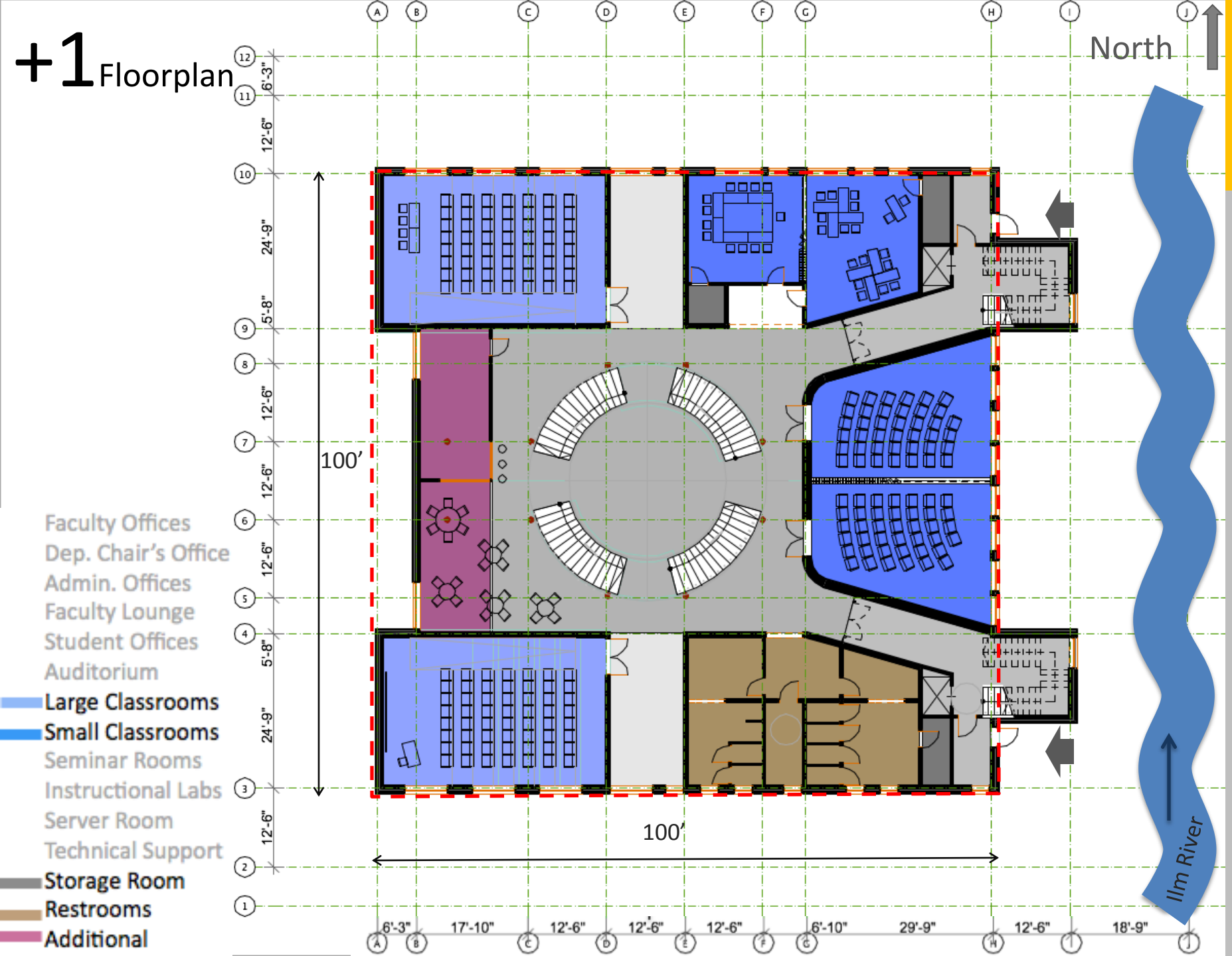
E

C

L

S

+1 Floorplan


North
A
E
C
L
S
Ilm River
100'
100'
Faculty Offices
Dep. Chair's Office
Admin. Offices
Faculty Lounge
Student Offices
Auditorium
Large Classrooms
Small Classrooms
Seminar Rooms
Instructional Labs
Server Room
Technical Support
Storage Room
Restrooms
Additional

Atrium Area

A

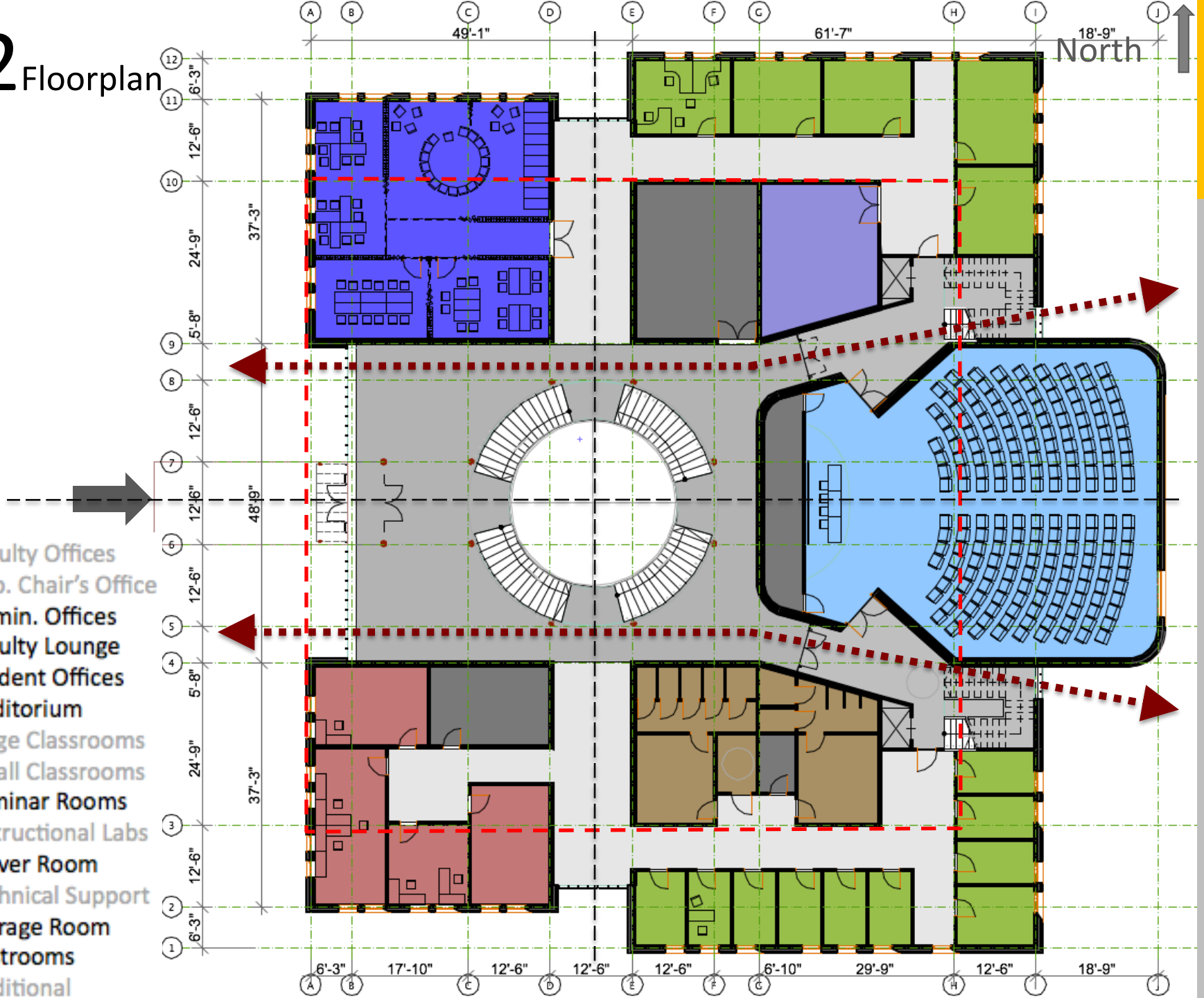
E

C

L

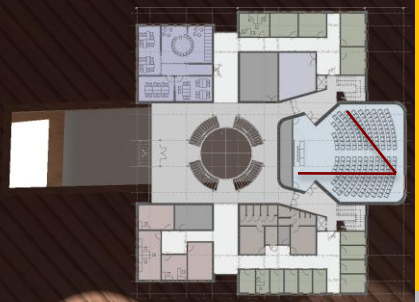
S

+2 Floorplan



- Faculty Offices
- Dep. Chair's Office
- Admin. Offices
- Faculty Lounge
- Student Offices
- Auditorium
- Large Classrooms
- Small Classrooms
- Seminar Rooms
- Instructional Labs
- Server Room
- Technical Support
- Storage Room
- Restrooms
- Additional

Auditorium Interior



A

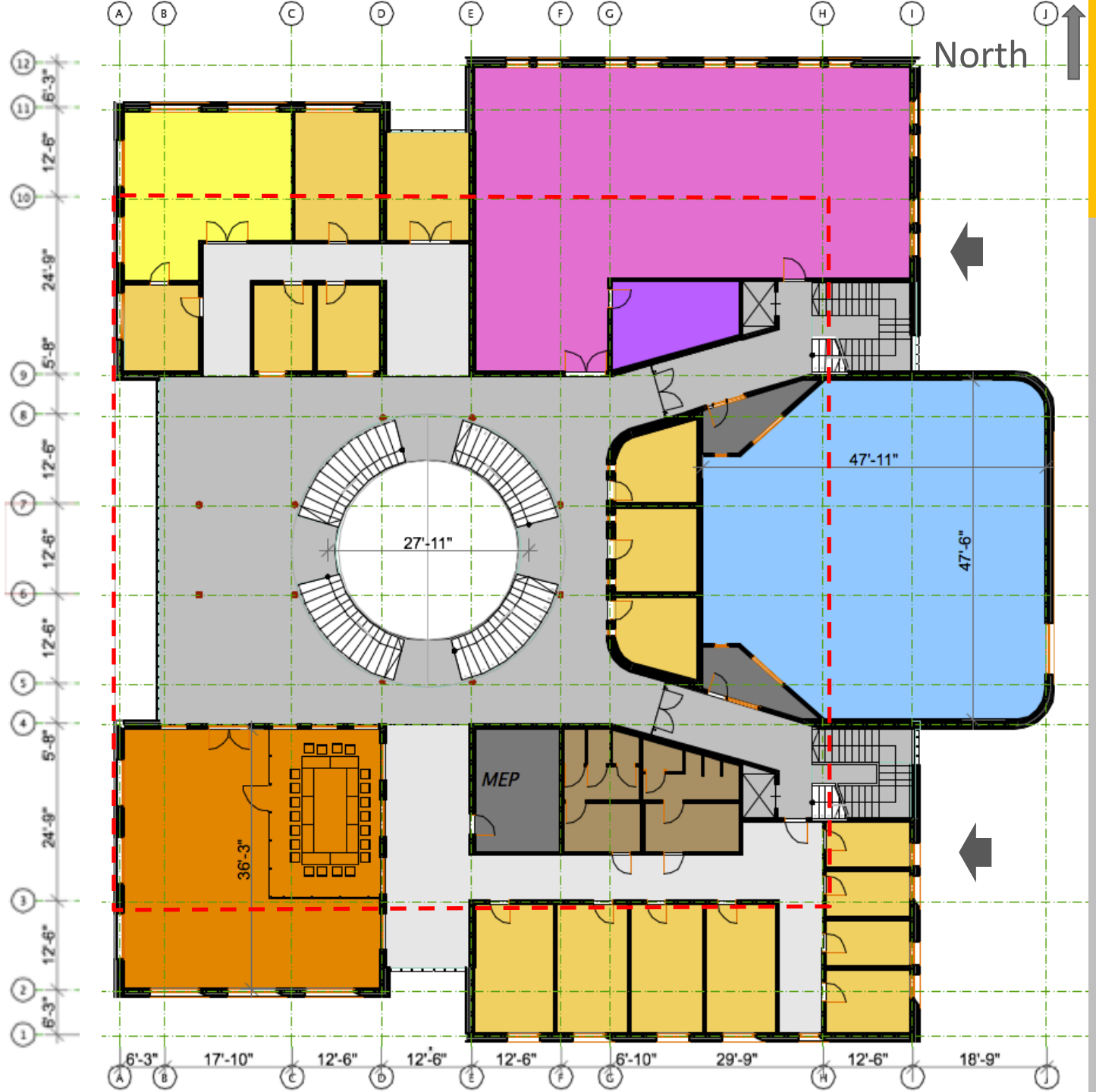
E

C

L

S

+3 Floorplan



- Faculty Offices
- Dep. Chair's Office
- Admin. Offices
- Faculty Lounge
- Student Offices
- Auditorium
- Large Classrooms
- Small Classrooms
- Seminar Rooms
- Instructional Labs
- Server Room
- Technical Support
- Storage Room
- Restrooms
- Additional

A

E

C

L

S

Atrium Area

A

E

C

L

S

Main Entrance view

A

E

C

L

S

West Façade [city, entrance]

East Façade [river, parc]

A

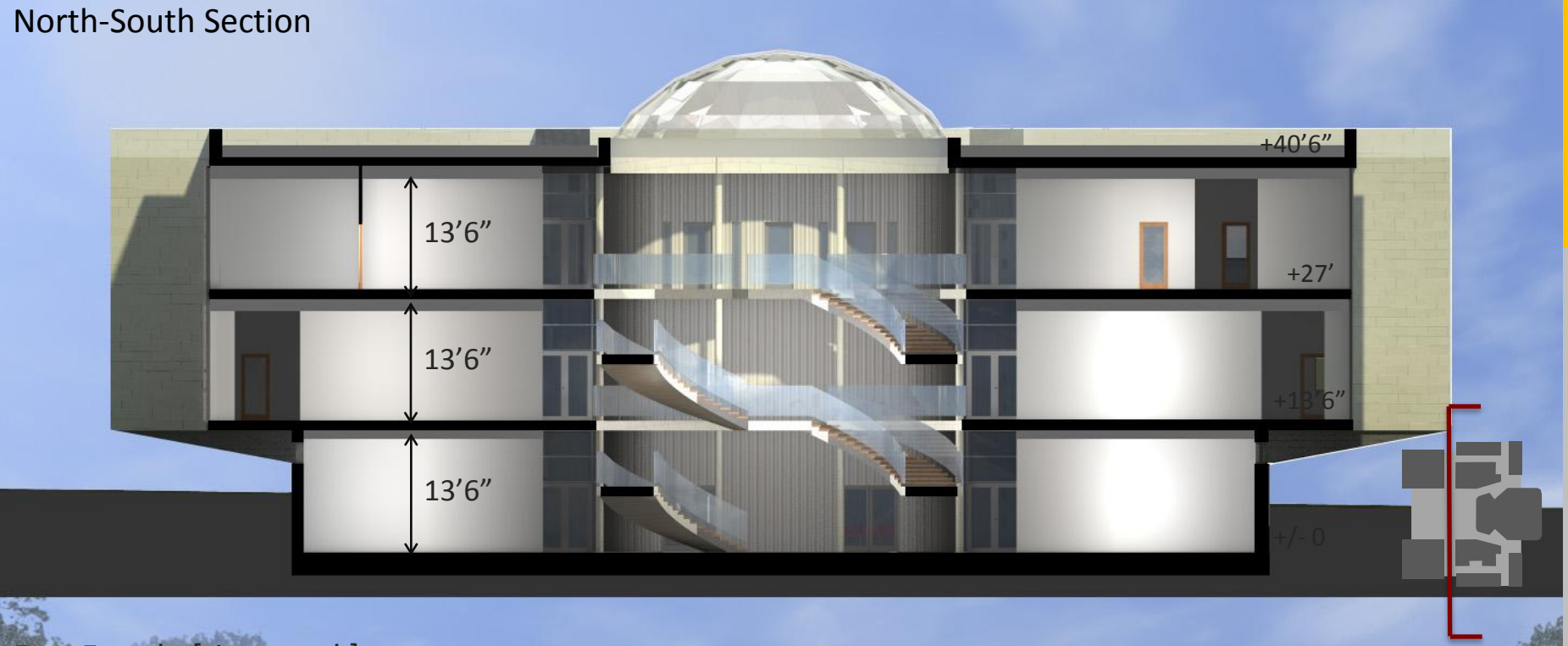
E

C

L

S

North-South Section



East Façade [river, park]

A E C L S

North Façade

South Façade

A

E

C

L

S

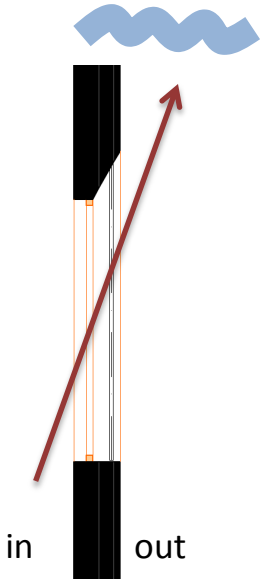
North Façade

East-West Section

A E C L S

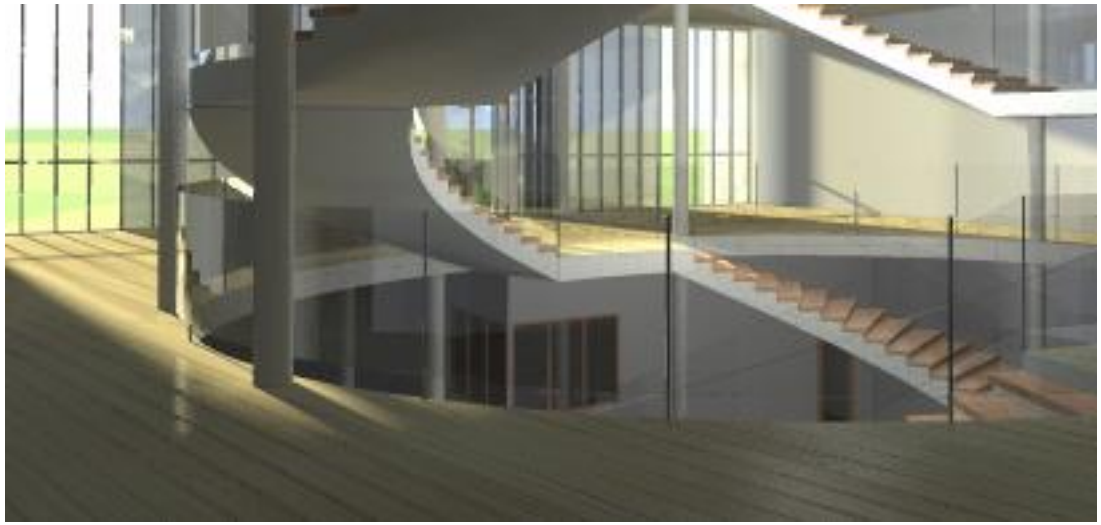
Details Materials, Small Architecture

Slanted windows -> river view

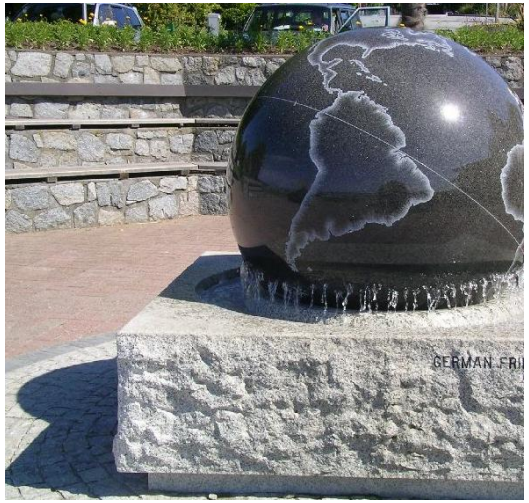


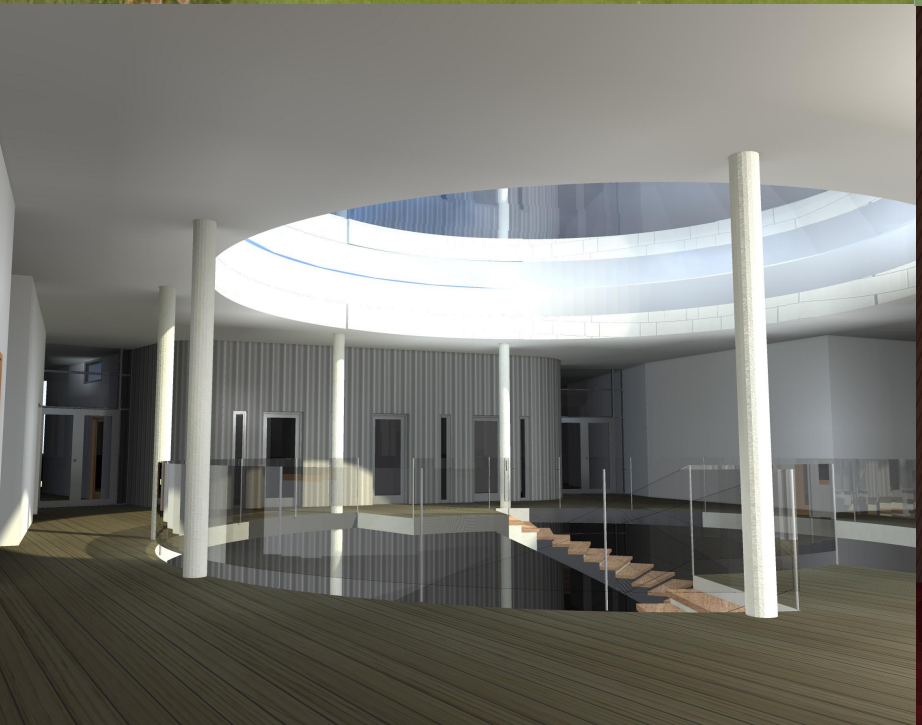
Benches (reused stone)

Glass handrails in circular staircase



Stone Sphere-fountain
(in the middle of atrium, +1)





A

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C

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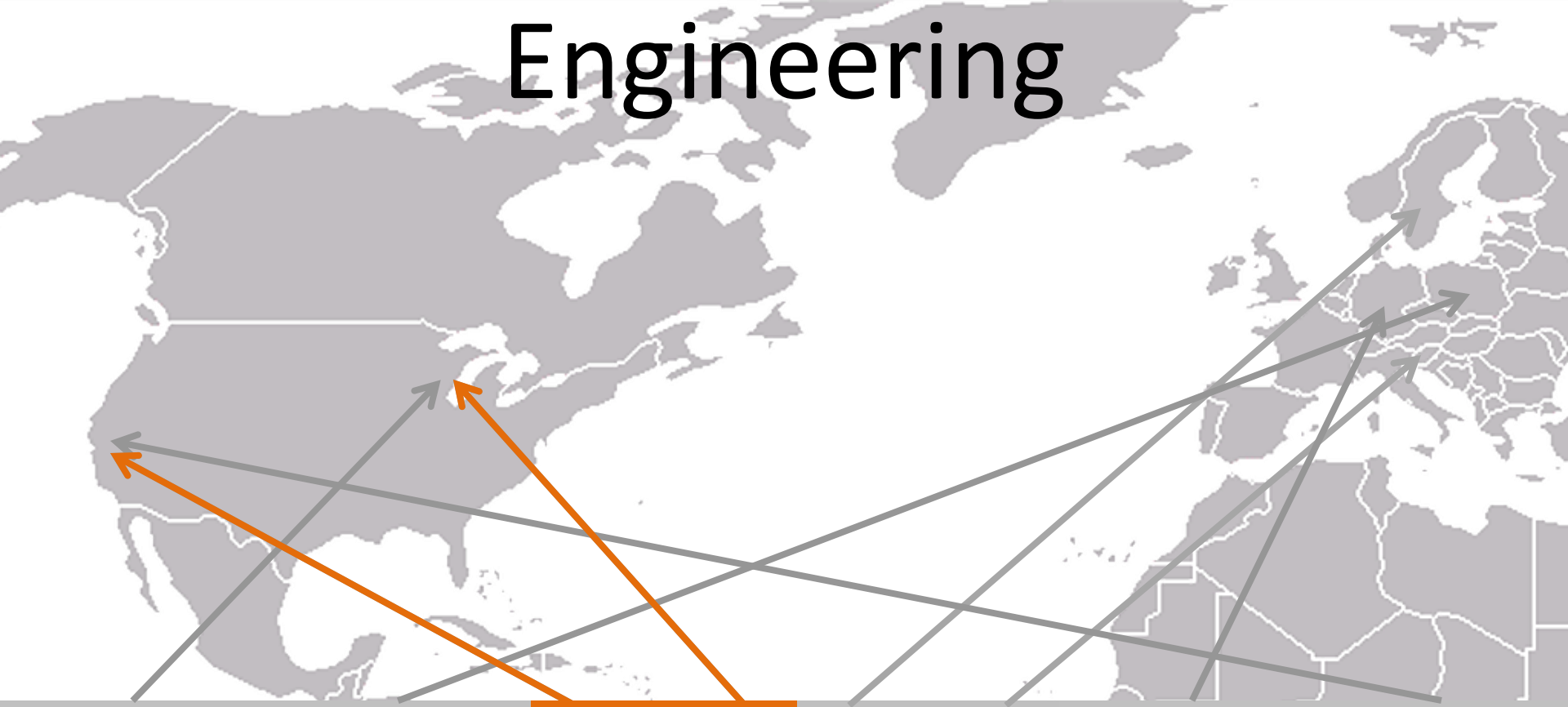
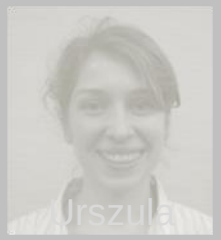
Engineering



Owner | A | E | C | L | S


David


Urszula

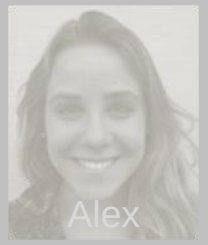

Joanna


Brent


Nima


Martin


Sebastian


Alex

Loading Considerations

Gravity Loads

DEAD LOADS:

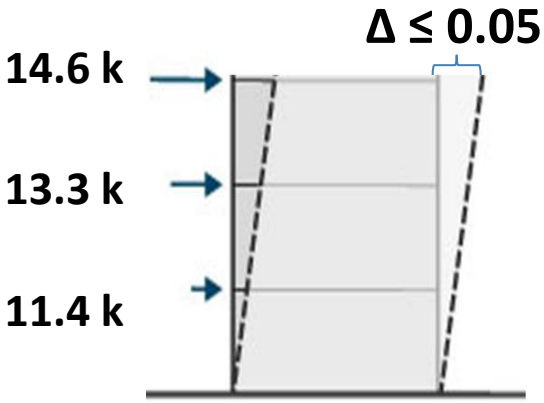
MEP	5 psf
CLADDING	20 psf
MISC	12 psf
SELF-WEIGH	80 to 100 psf

LIVE LOADS:

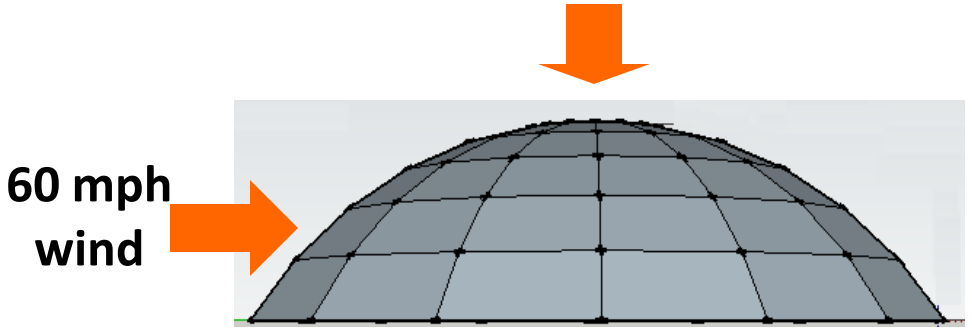
ROOF	20 psf
SNOW	40 psf
CLASSROOM	50 psf
OFFICE	50 psf
AUDITORIUM	60 psf
LABORATORY ROOM	100 psf
CORRIDOR	100 psf
STORAGE	120 psf
PARTITIONS	*20 psf*

Lateral Loads

AVERAGE WIND LOAD	12 mph
DESIGN WIND LOAD	60 mph

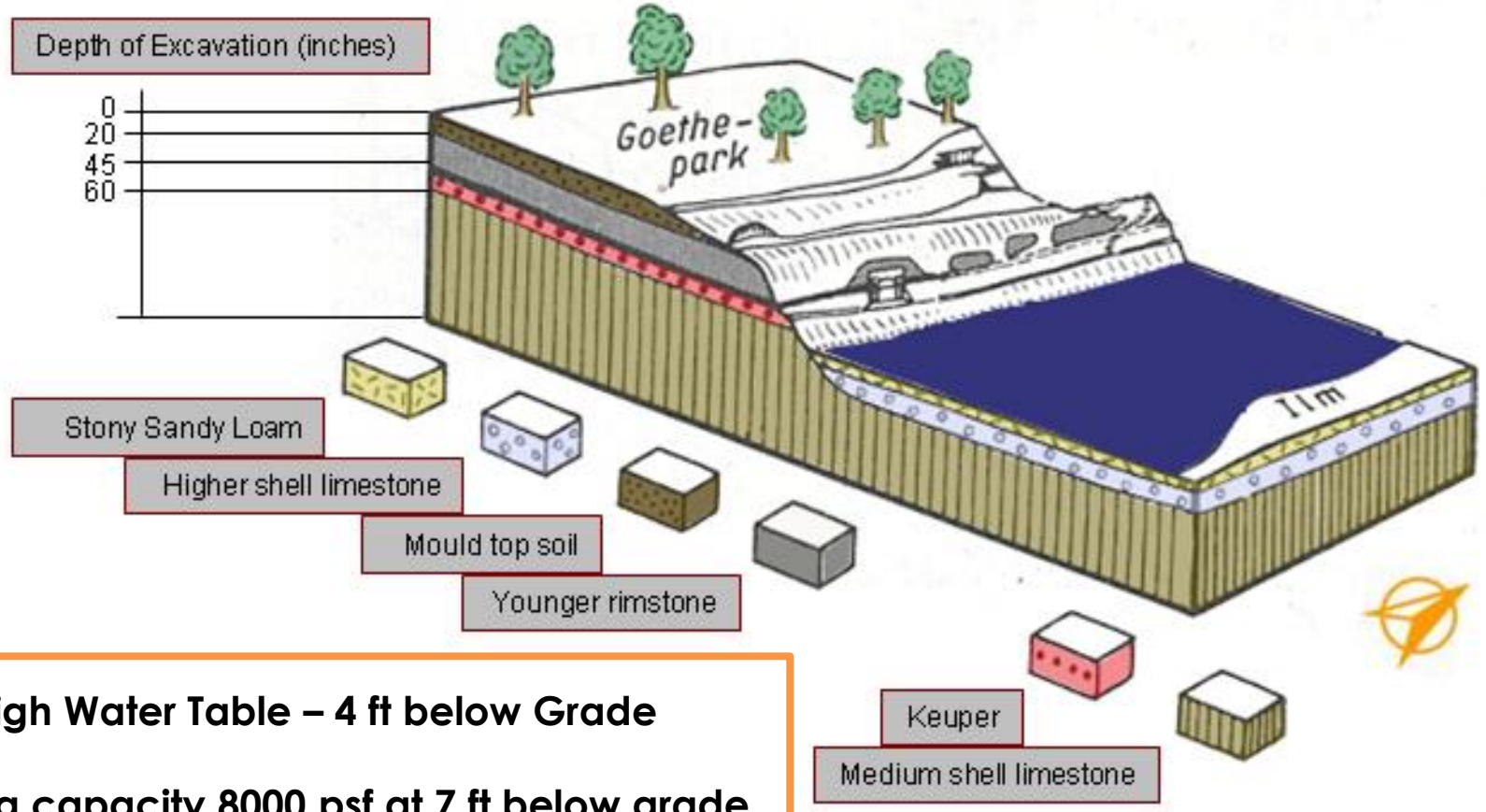


Dome Loads



A E C L S

Soil Considerations



High Water Table – 4 ft below Grade

Bearing capacity 8000 psf at 7 ft below grade

Excavation needed

Building will not be under water table

A

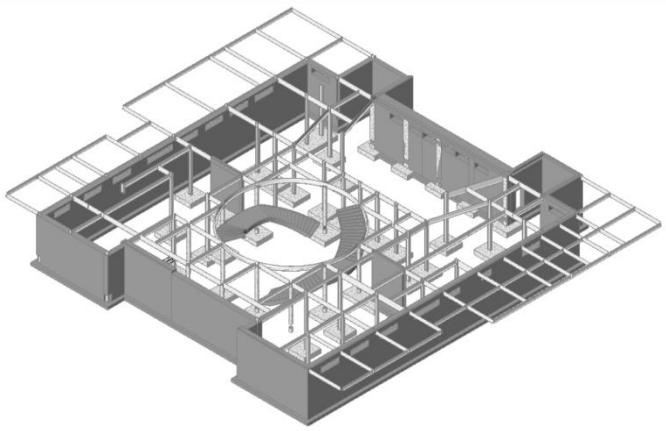
E

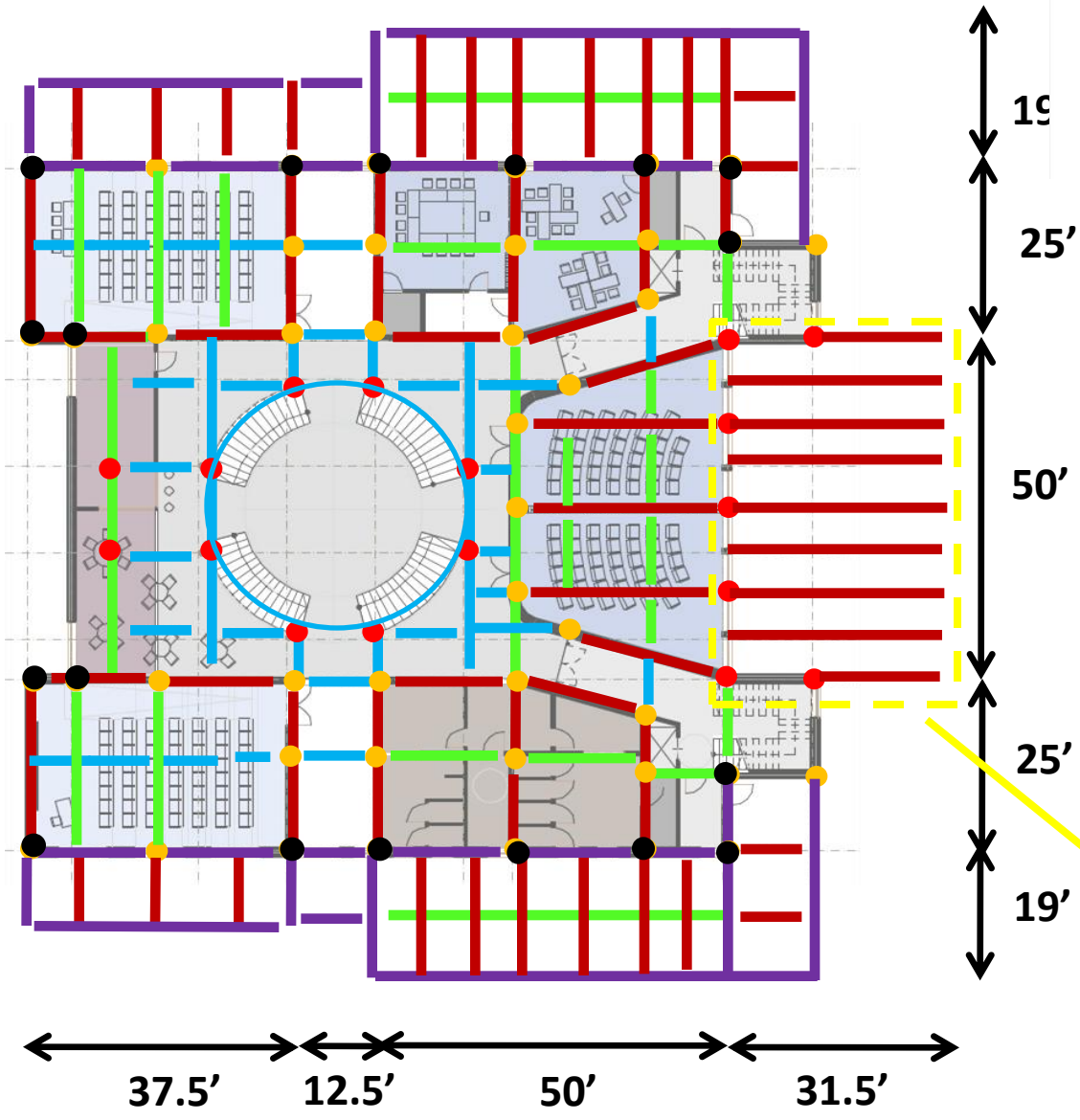
C

L

S

Structural Plan + 1



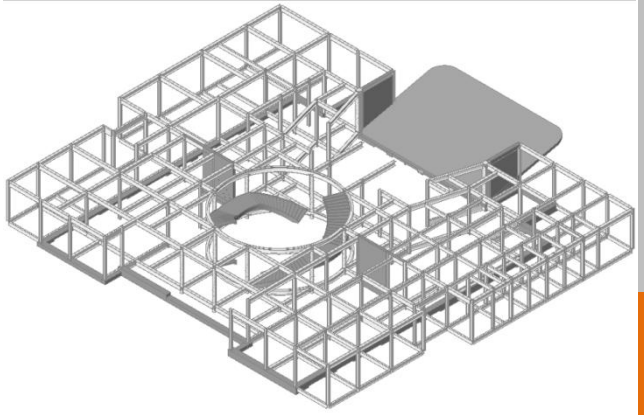


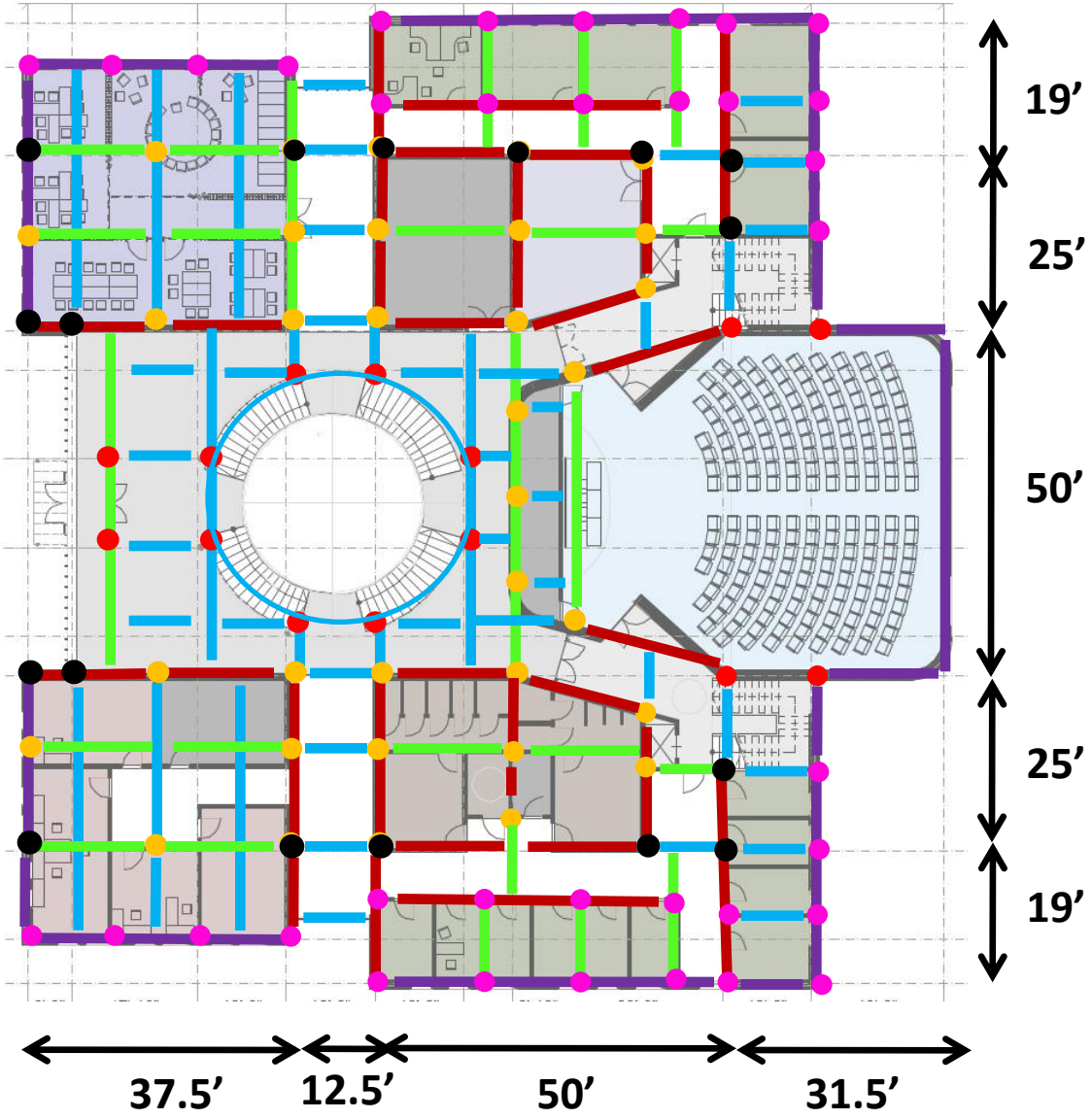
- W 14 x 30
- W 16 x 77
- W 18 x60
- W 24 x 55
- Concrete Column
- Steel Column
  - W14x61
  - W12x60
  - W10x 61

Sloped to support cantilever

A E C L S

Structural Plan + 2

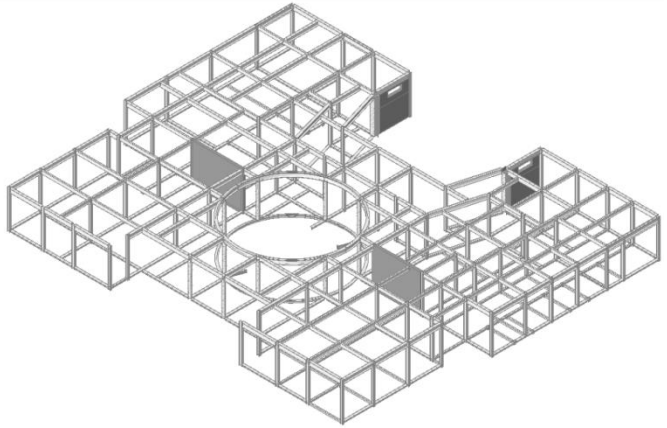


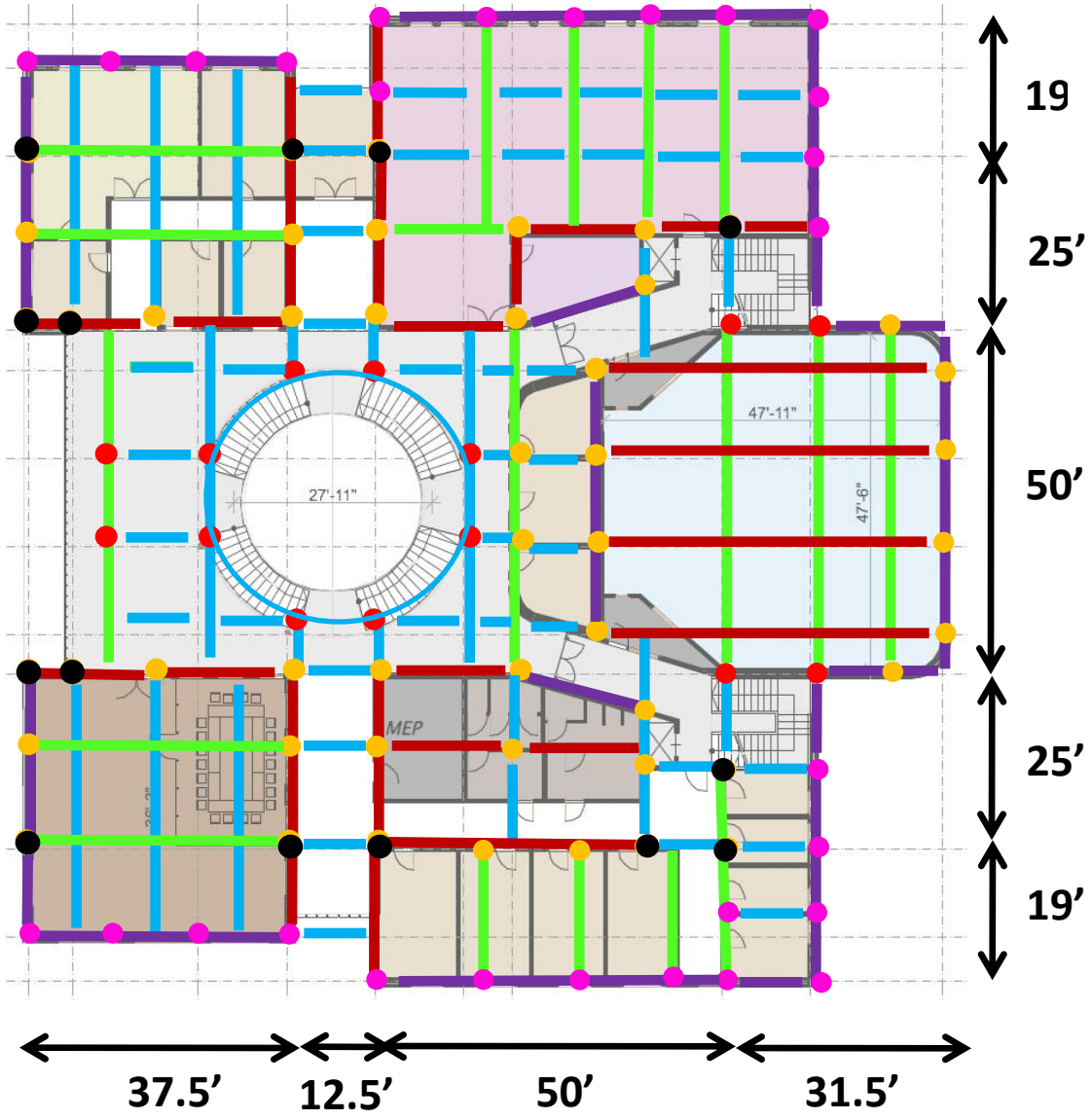


- W 14 x 30
- W 16 x 77
- W 18 x60
- W 24 x 55
- Concrete Column
- Steel Column
  - W14x61
  - W12x60
  - W10x 61

A E C L S

Structural System + 3

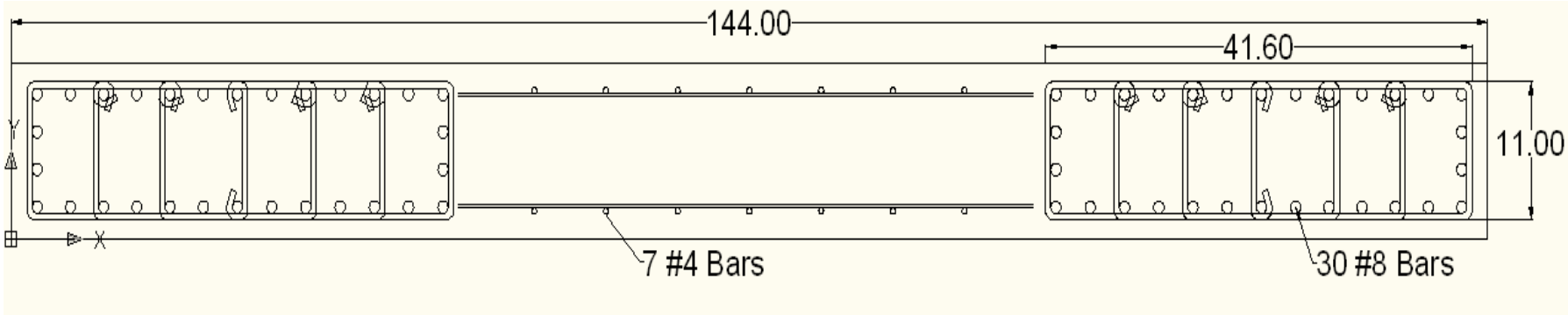




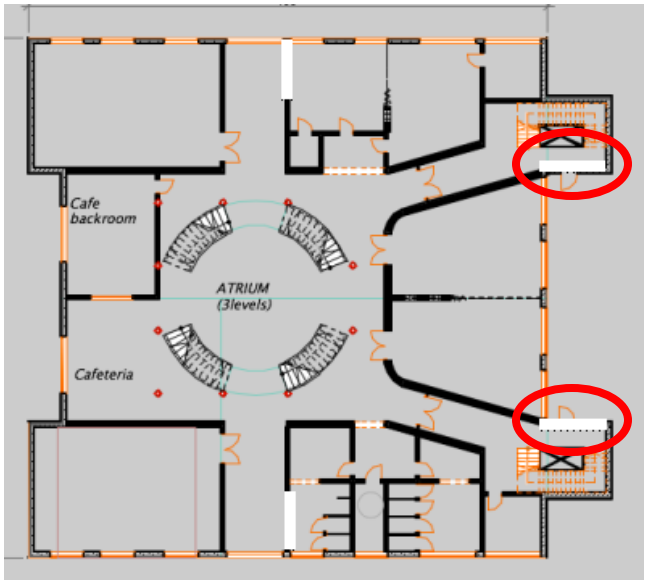
- W 14 x 30
- W 16 x 77
- W 18 x60
- W 24 x 55
- Concrete Column
- Steel Column
  - W14x61
  - W12x60
  - W10x 61

Shear Wall Design

Shear Wall Detail

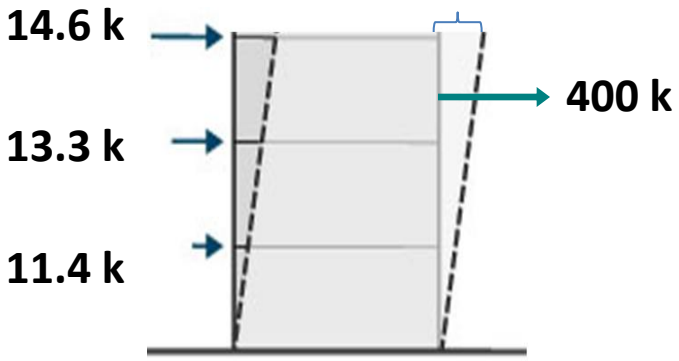


Shear Wall Location



Wind Load

Cantilever Load



Design Moment = 13,000 k-ft

A

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C

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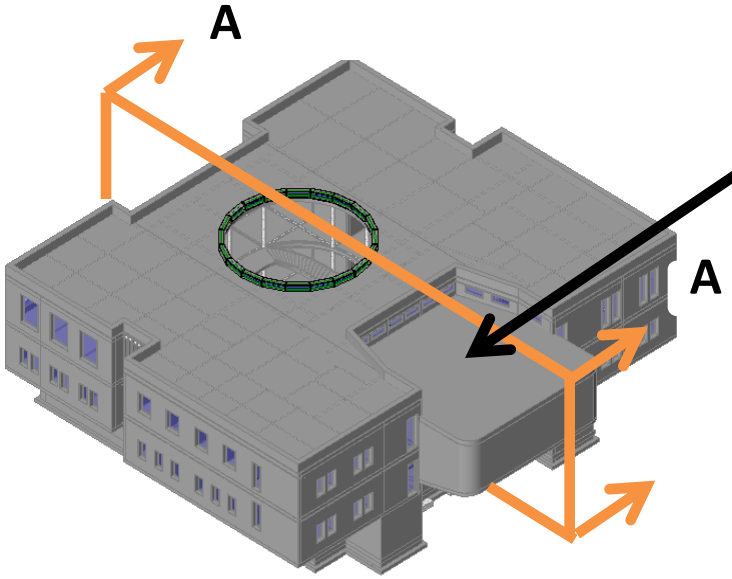
S

Reinforced Concrete Steel Framing



Auditorium Supported by:
- 3 – 12” square columns
- 2 – 18” square columns
- 2 – concrete shear walls

Concrete

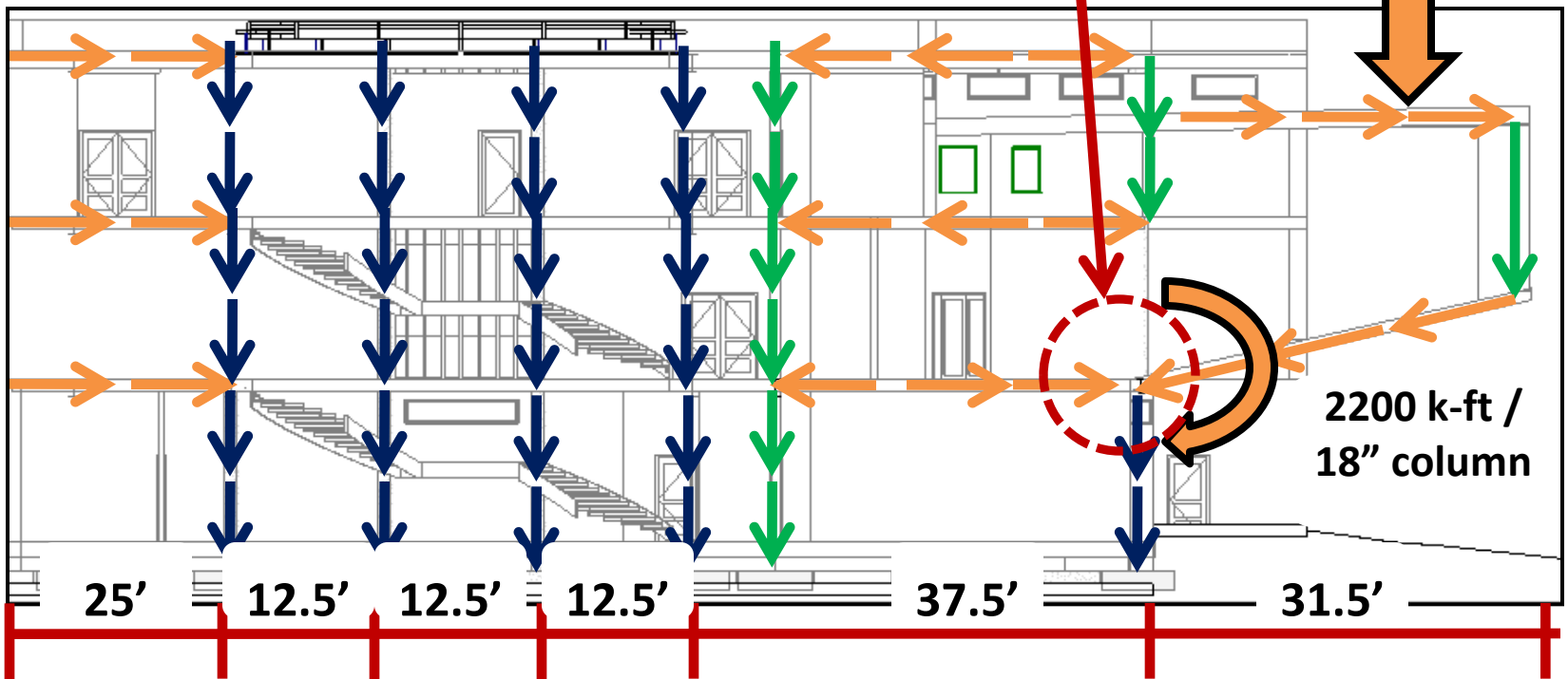
Steel

Composite deck

Most Challenging Connection

3200 kips

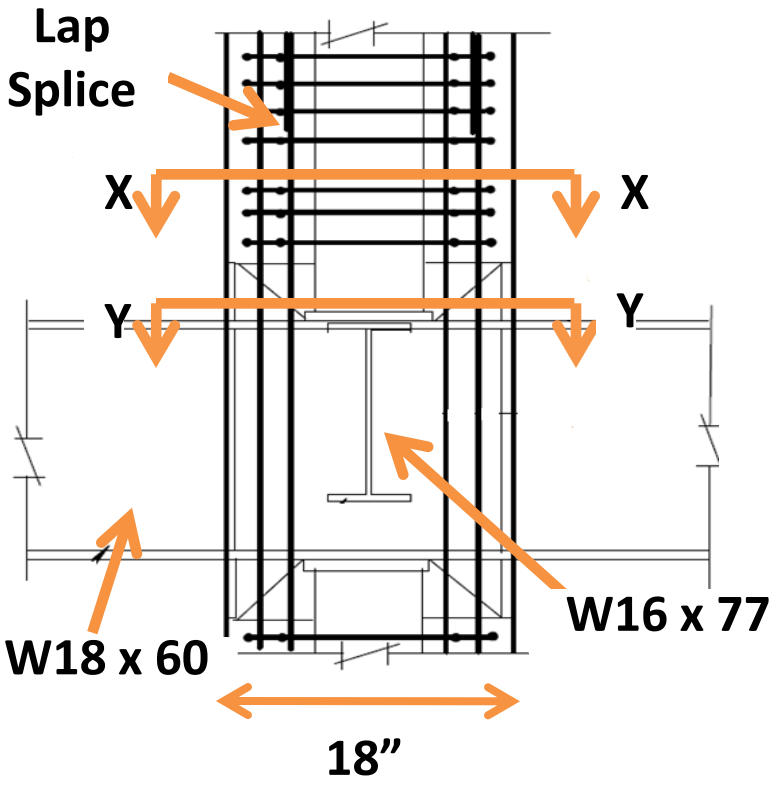
Section A - A



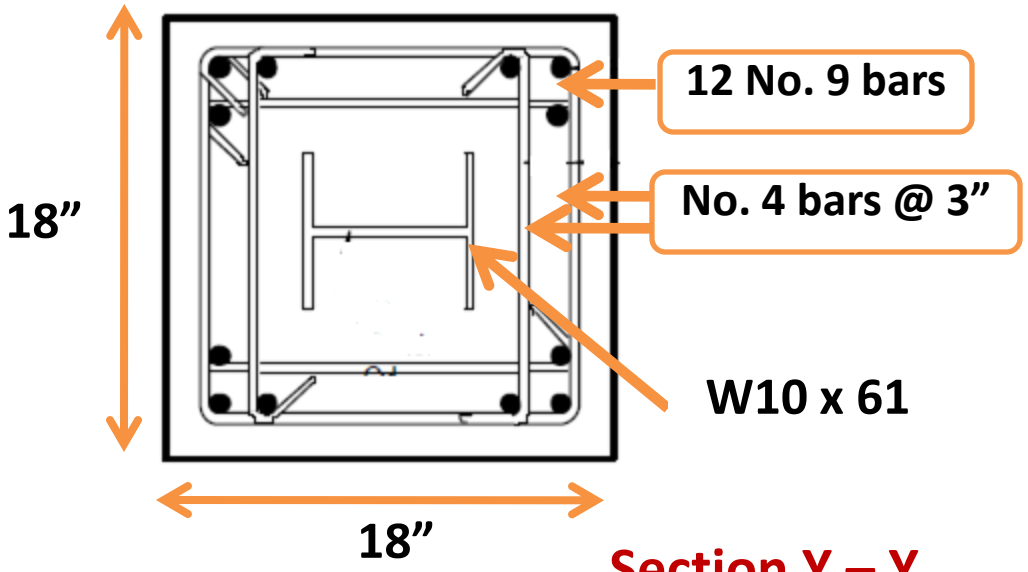
A E C L S

Reinforced Concrete Steel Framing

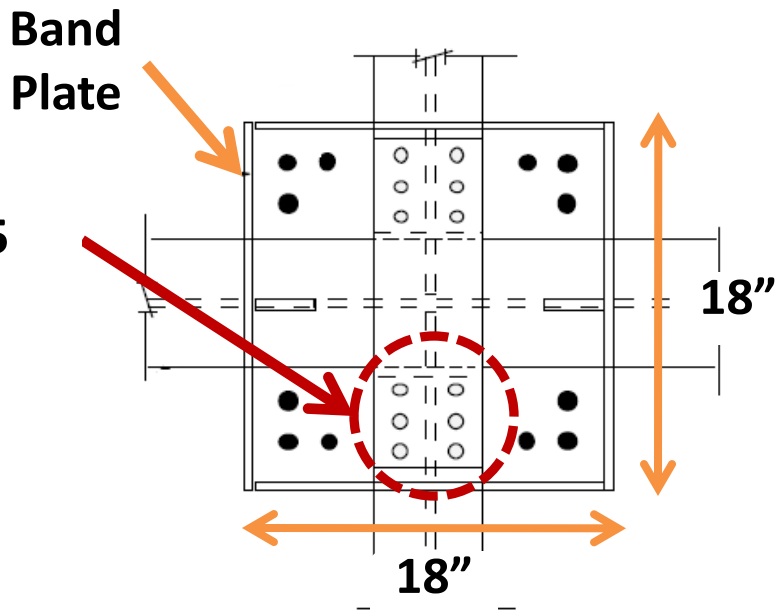
Steel Beam to Concrete Column



Section X - X



Section Y – Y

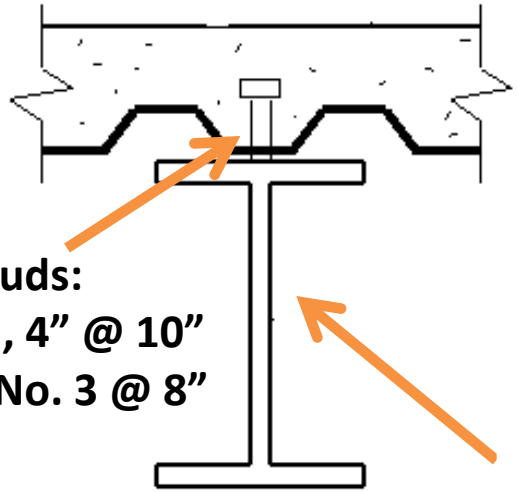


A E C L S

Connections

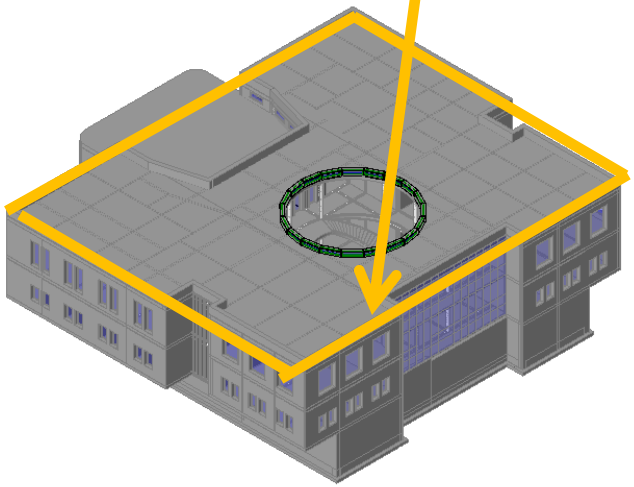
Composite Deck

6 ½” LWC – 3VLI18



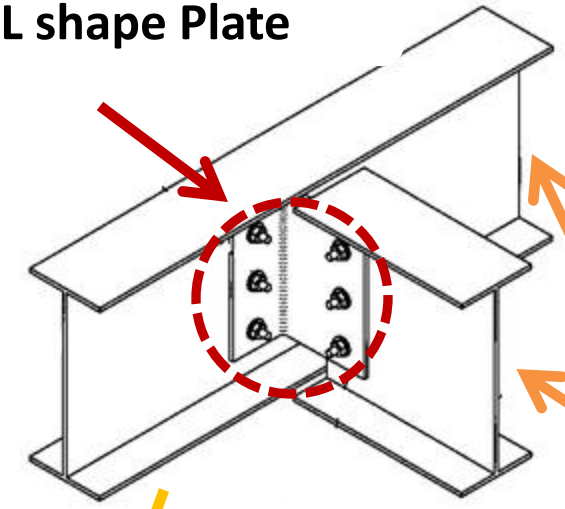
Studs:
¾” diam, 4” @ 10”
Rebars: No. 3 @ 8”

W14x30

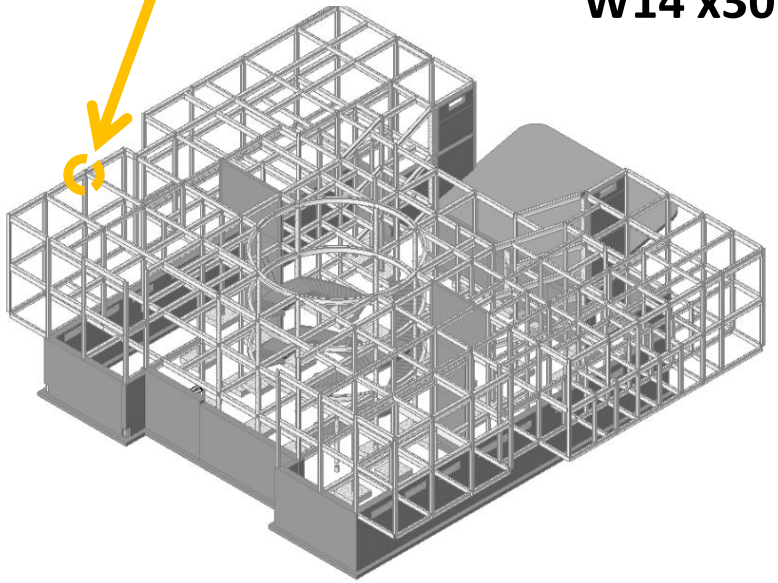


Steel to Steel

6 – 3/4” ASTM 325 bolts
½”- L shape Plate

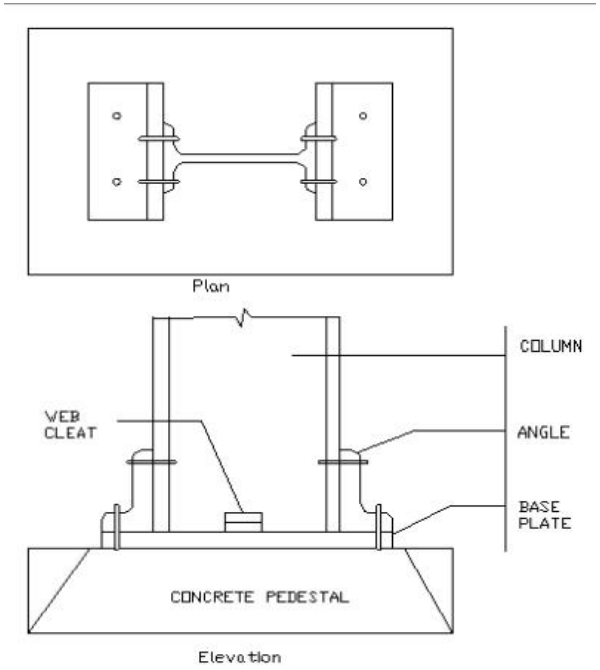


W14 x30

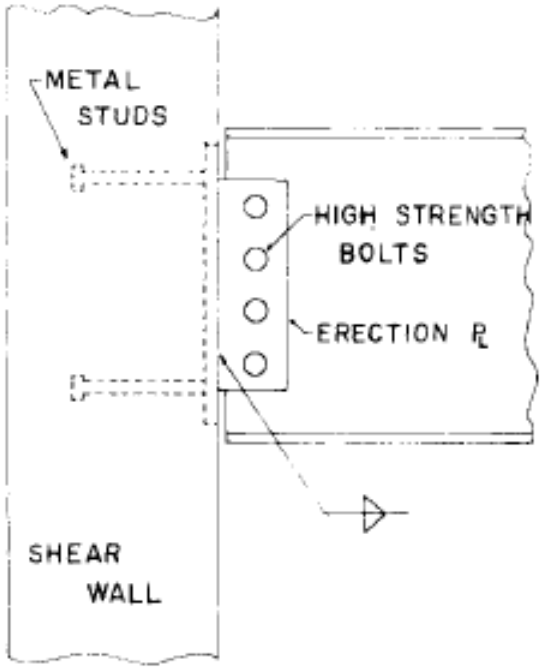


Connections

Footing



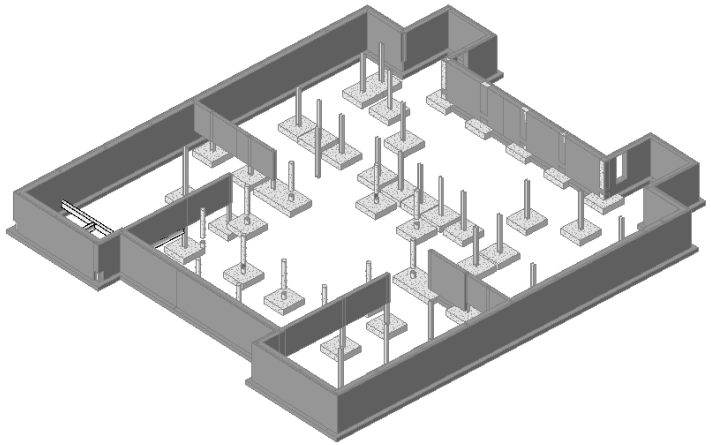
Steel beam to shear wall



Typical Sizes

Footing: 6’ x 6’ x 18”

Retaining Wall: 14”



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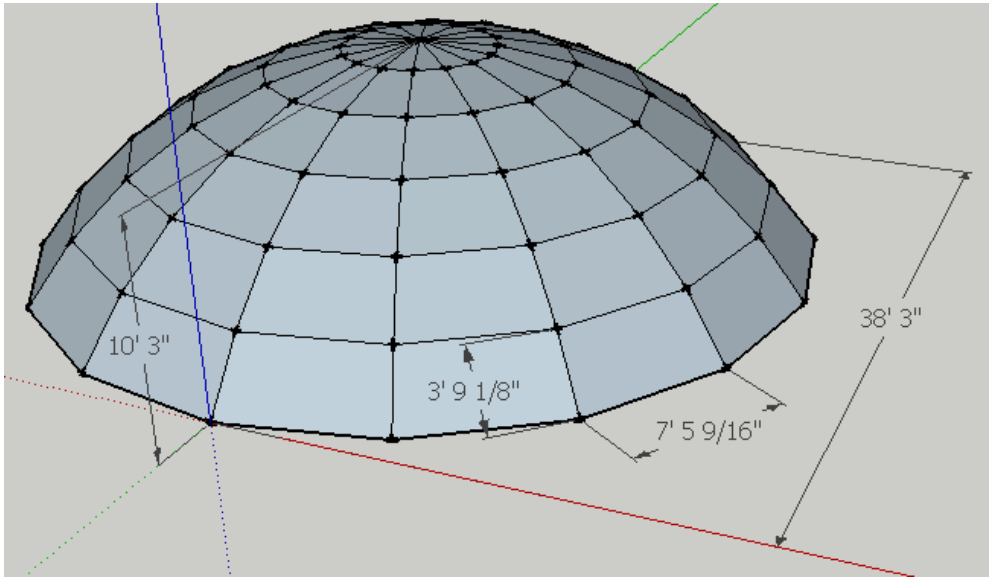
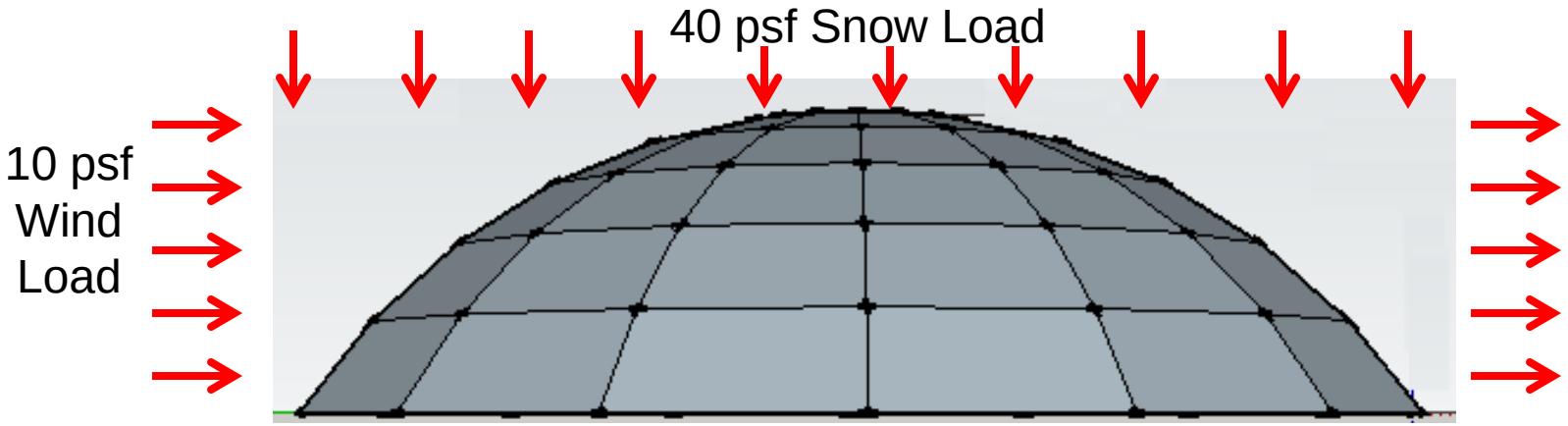
The Signature Dome

Section Model

Dome Layout



Loading Diagram



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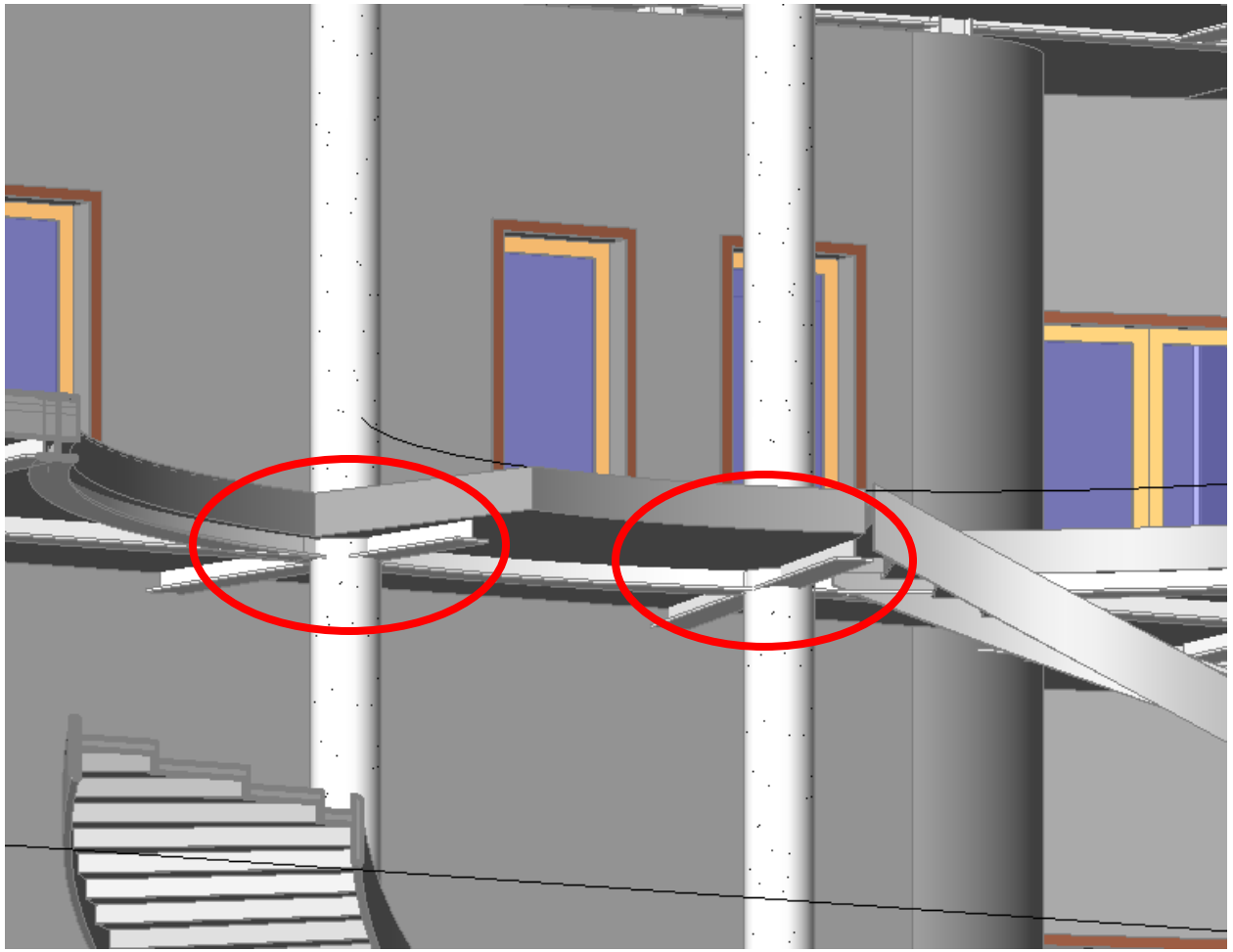
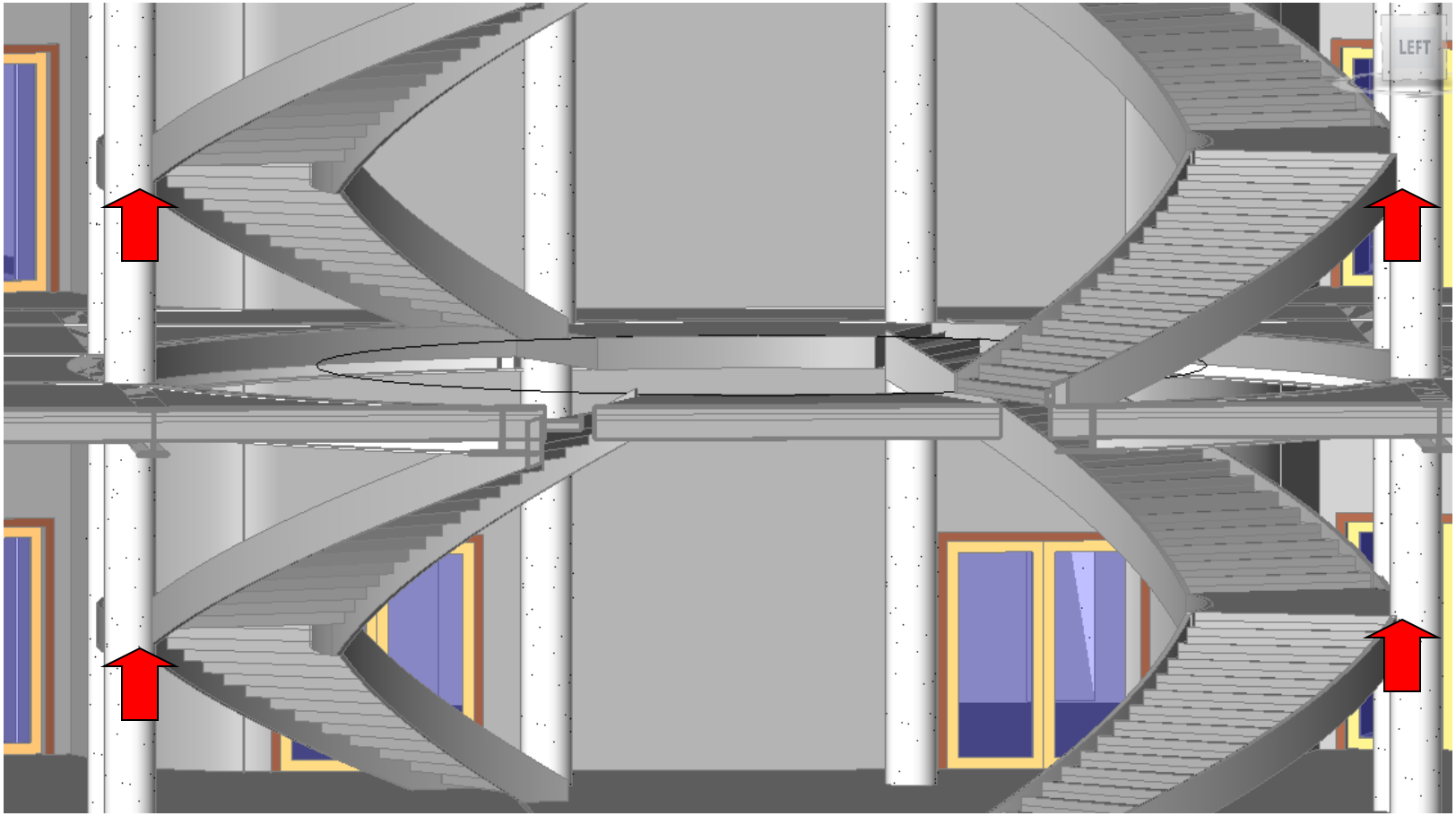
Spiral Stair Design

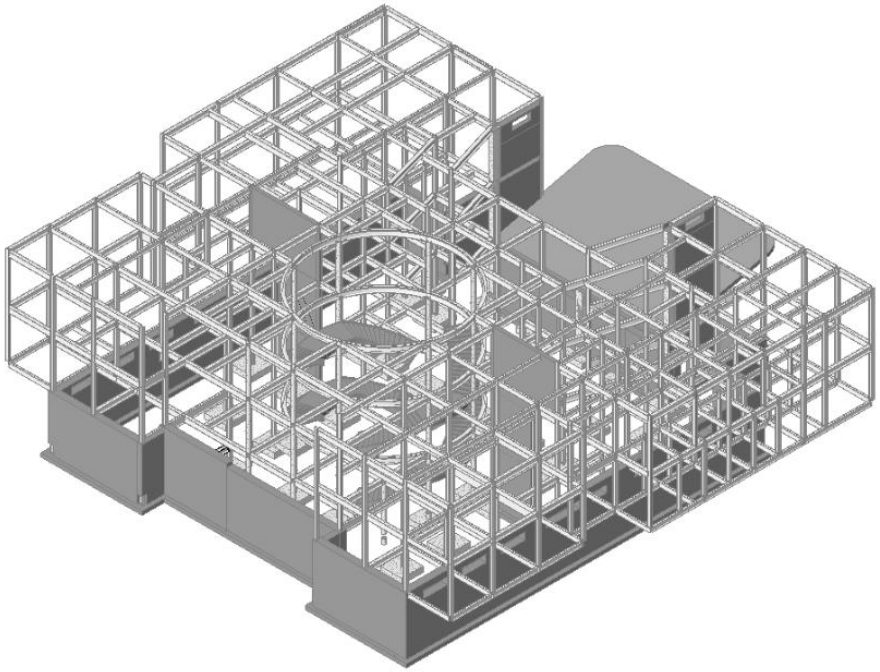
Main supports located at floor landings

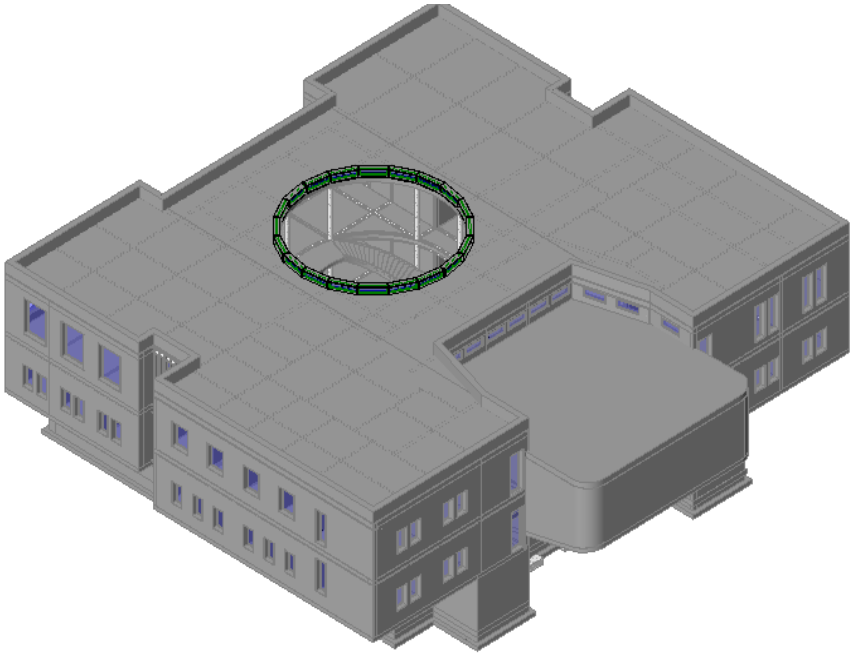


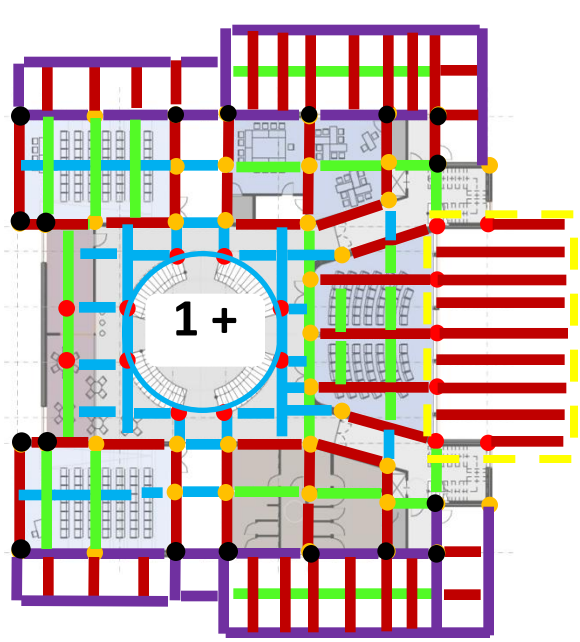
Spiral Stair Design

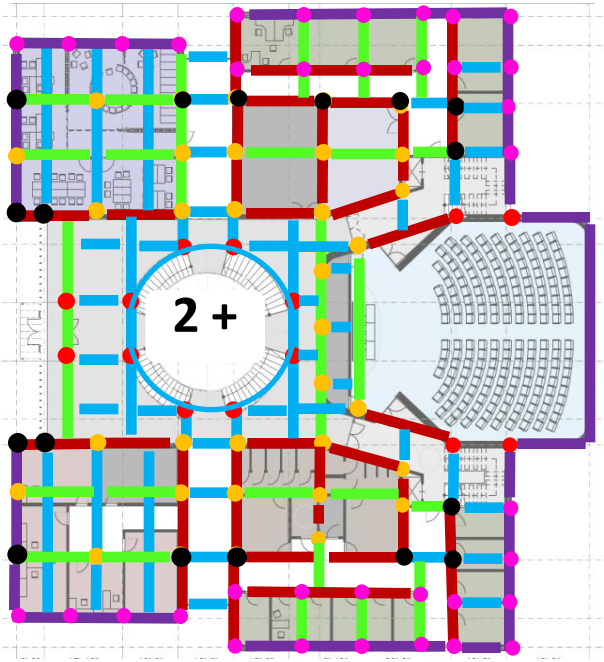
Additional supports at middle landings

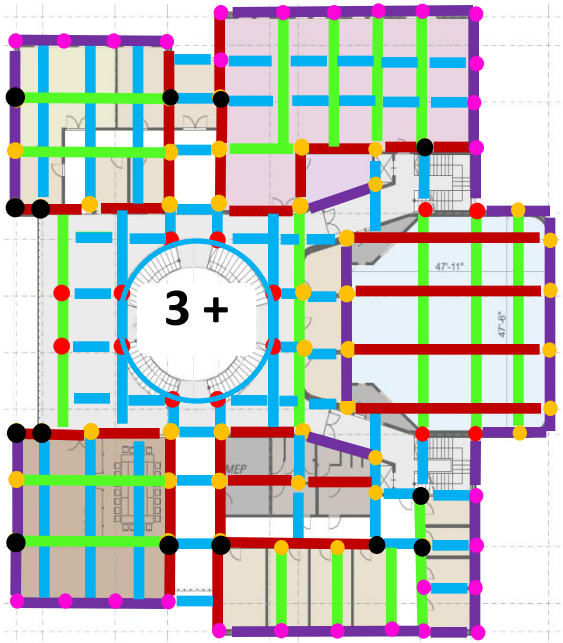












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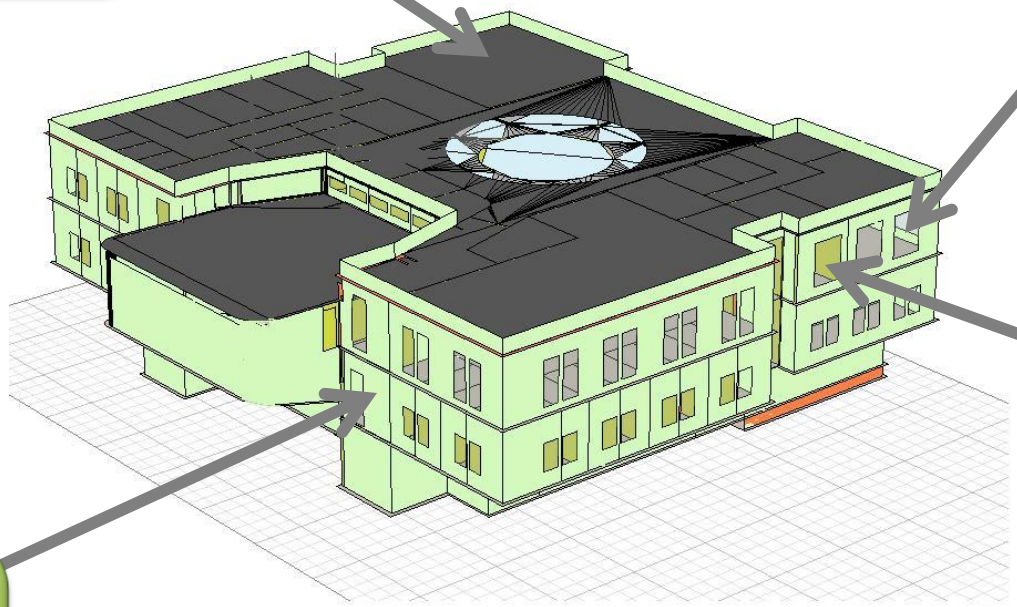
Sustainability

Owner A E C L S

Ecotect Model: Baseline Building

Roof: Foil Insulation, Polystyrene, LW Concrete, Plaster

Glass: Double Glazed, Timber Frame

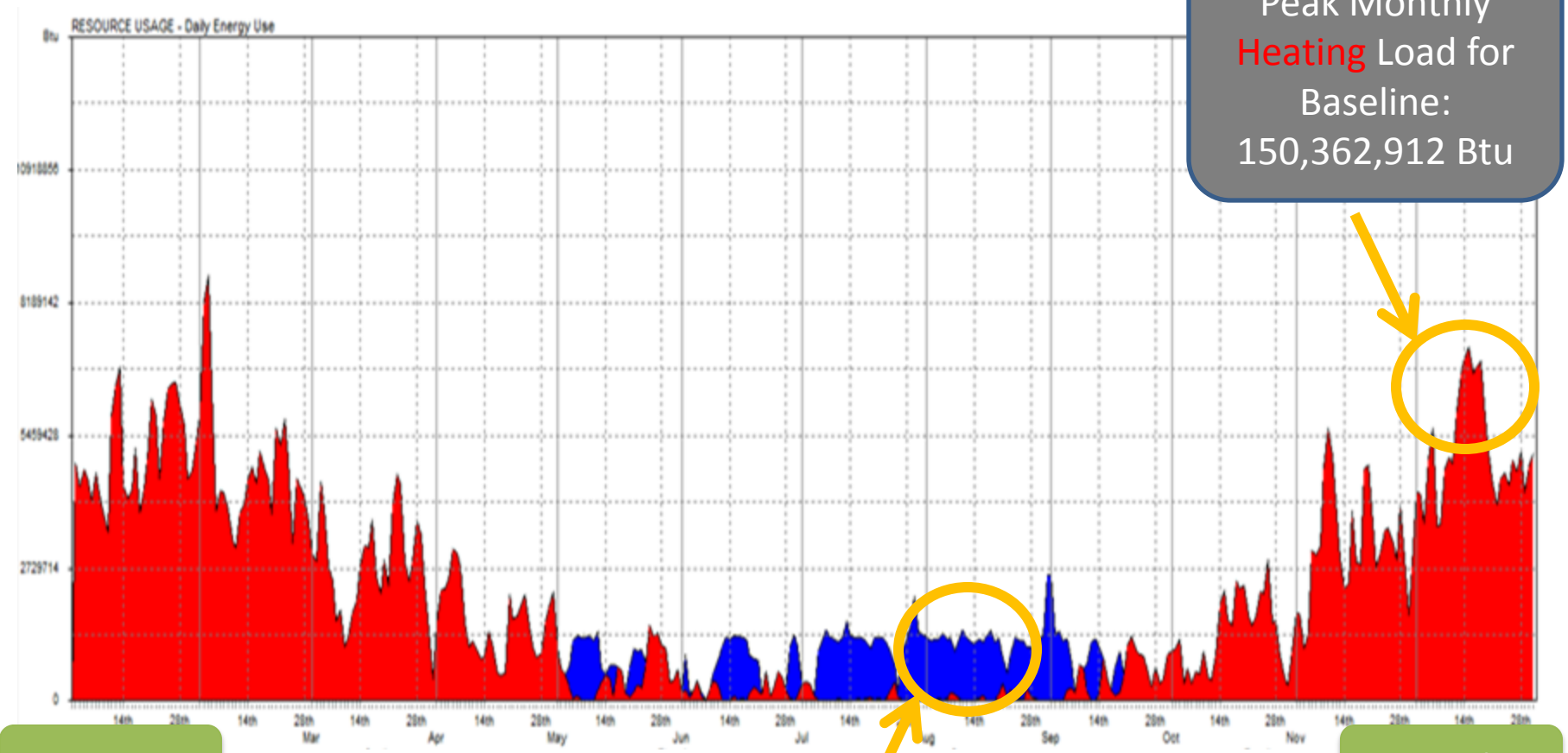


Interior Partitions: Plaster, Tile

Exterior Walls: Sandstone, Polystyrene, Concrete, Plaster

Mechanical: Dual-Duct, VAV system

Resource Consumption



Peak Monthly Heating Load for Baseline: 150,362,912 Btu

January

December

Peak Monthly Cooling Load for Baseline: 36,597,124 Btu

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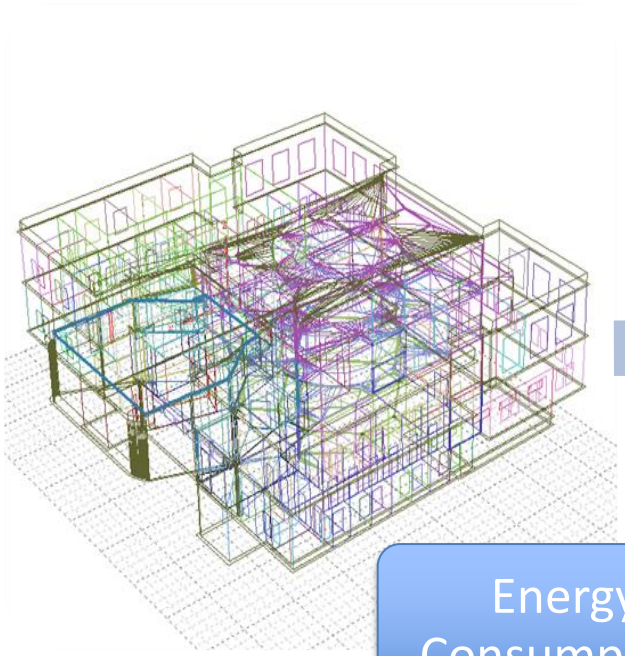
Geothermal



Energy Consumption from Ecotect

Geothermal System Sizing

- Heat Pump
- Tubing

Geothermal System = **50 tons less Carbon emitted** per year (than baseline)

26,000 ft tubing

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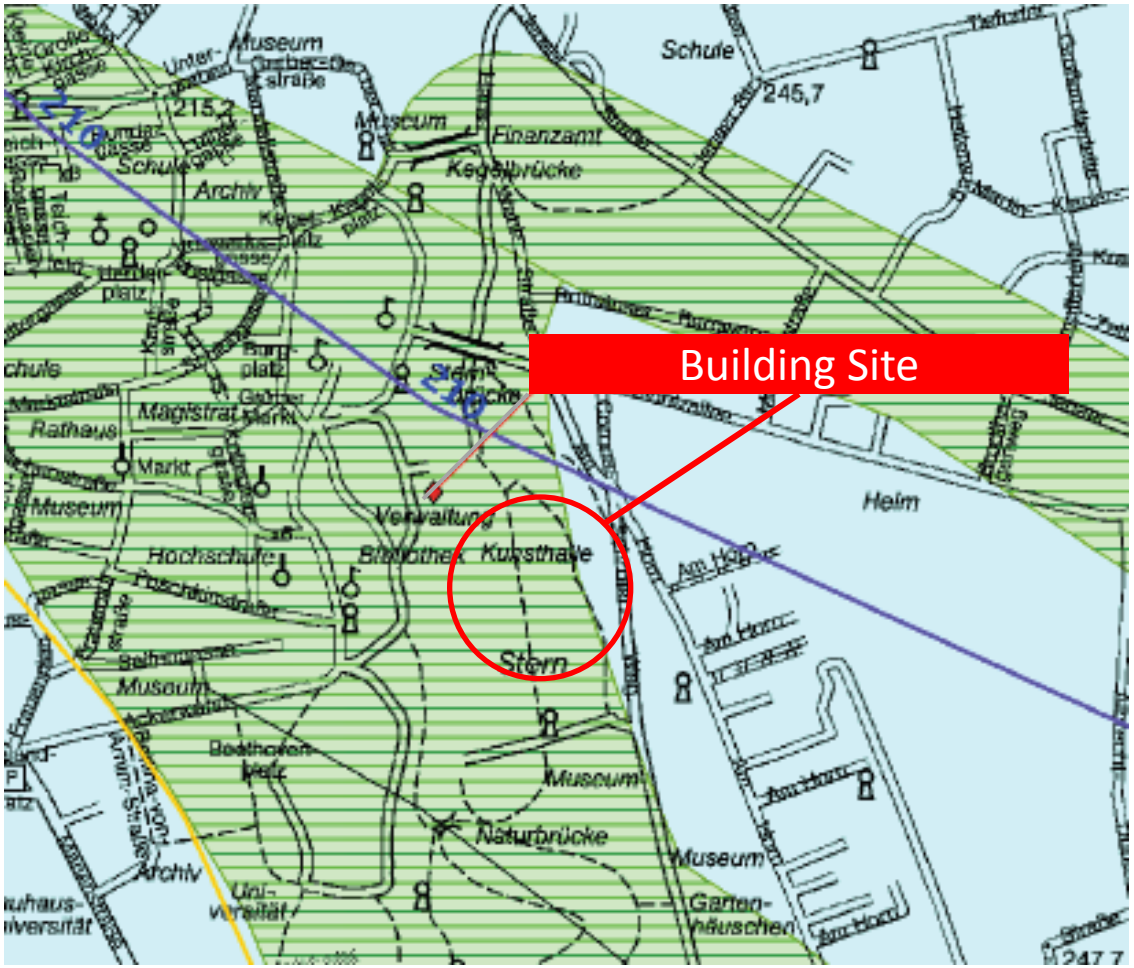
Geothermal

Soil Conditions



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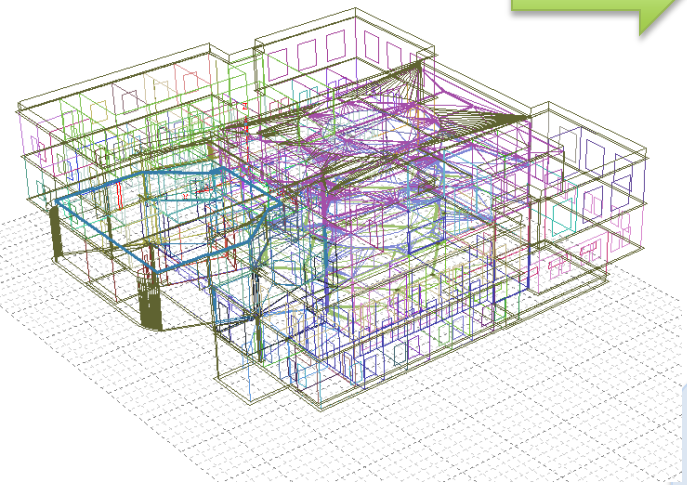
Insulation Options



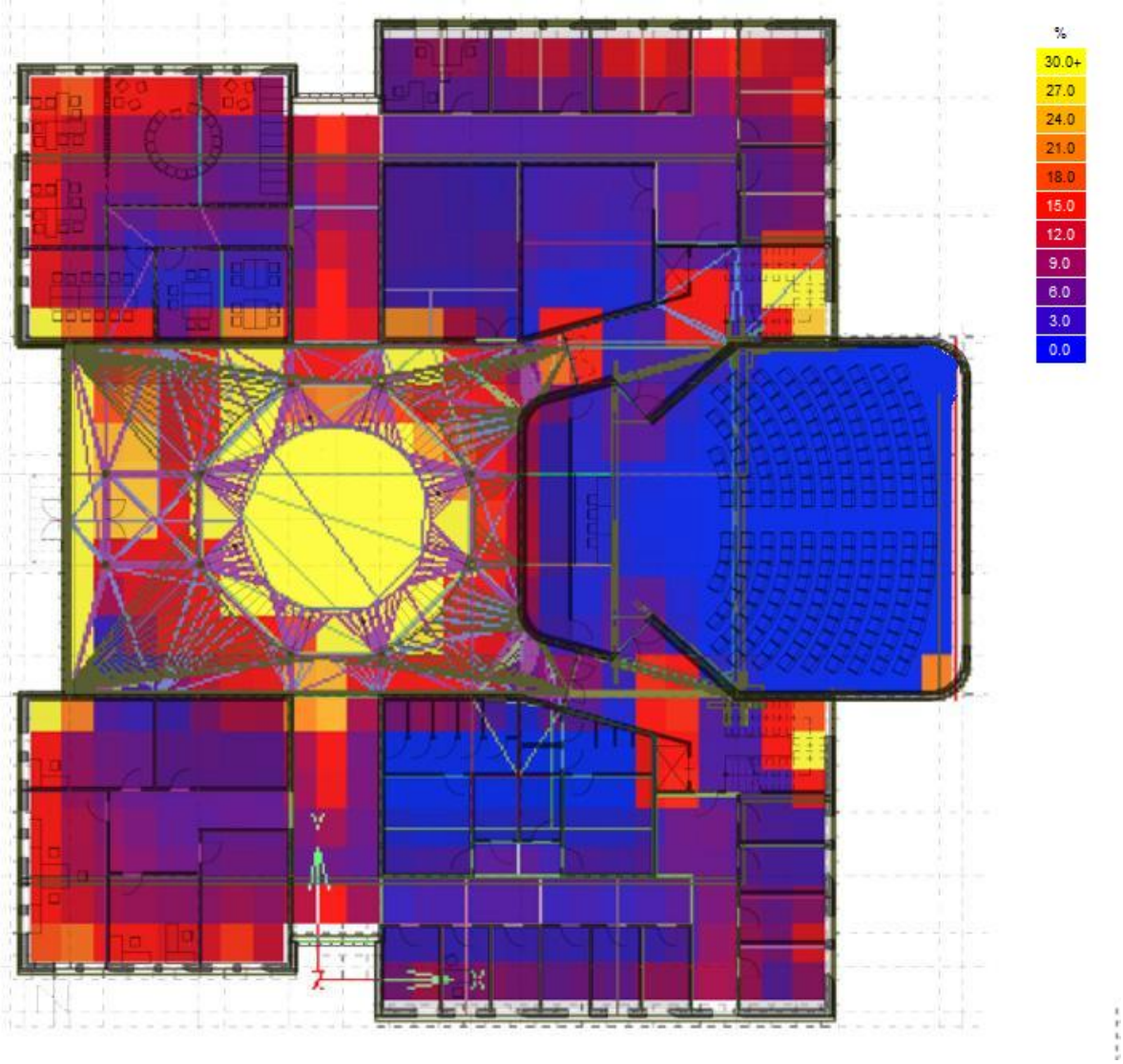
Expanded Polystyrene

Vacuum Insulation Panels + Expanded Polystyrene

7% reduction in heating using Vacuum Insulated Panels

A E C L S

Daylighting



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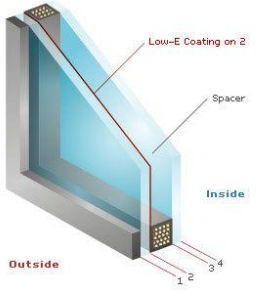
Glazing Options

Cooling Efficiency

Double Glazed, Low-e, Aluminum Frame



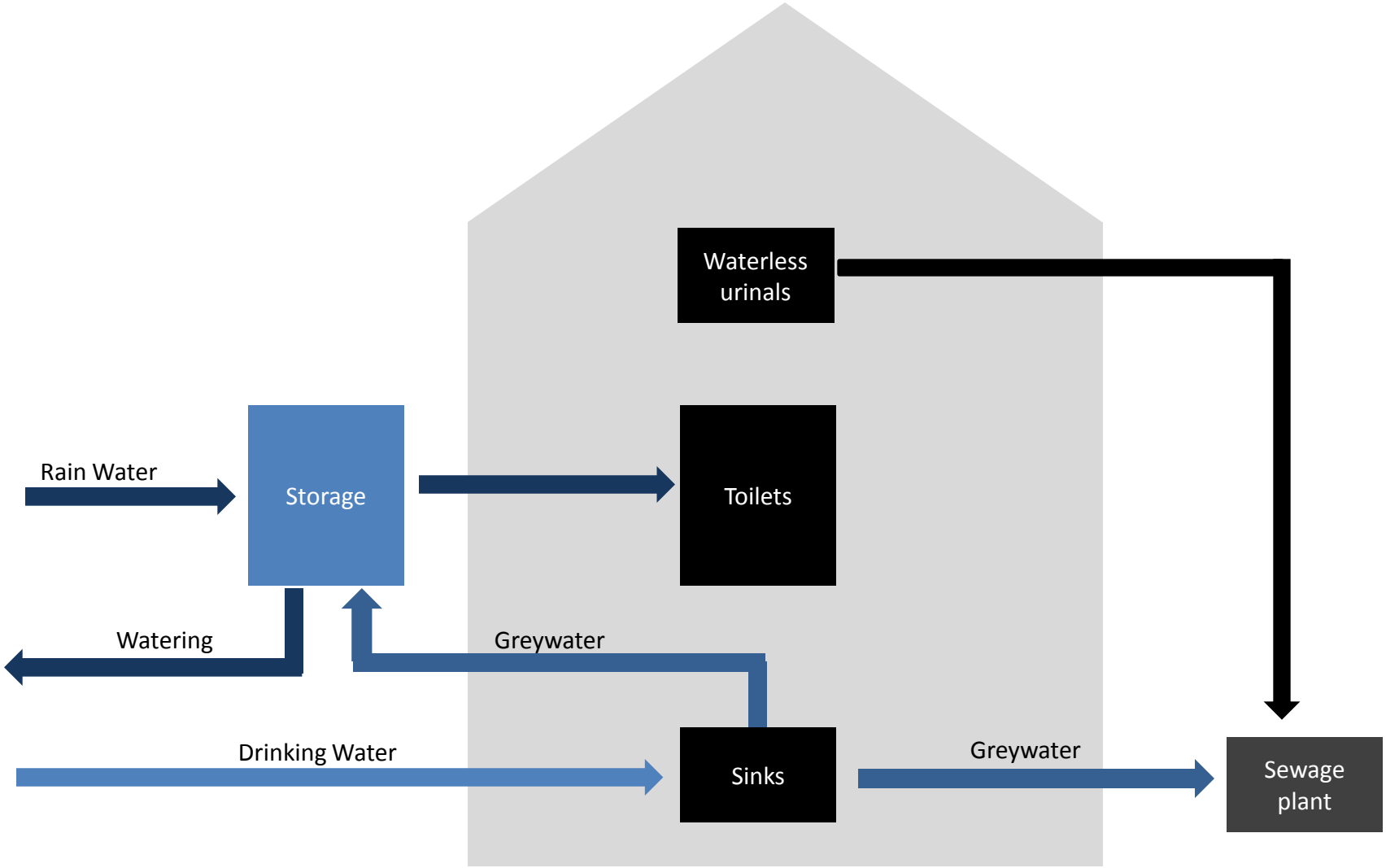
Double Glazed, Aluminum Frame

Double Glazed, Timber Frame

Heating Efficiency

A E C L S

Water Reuse System



A

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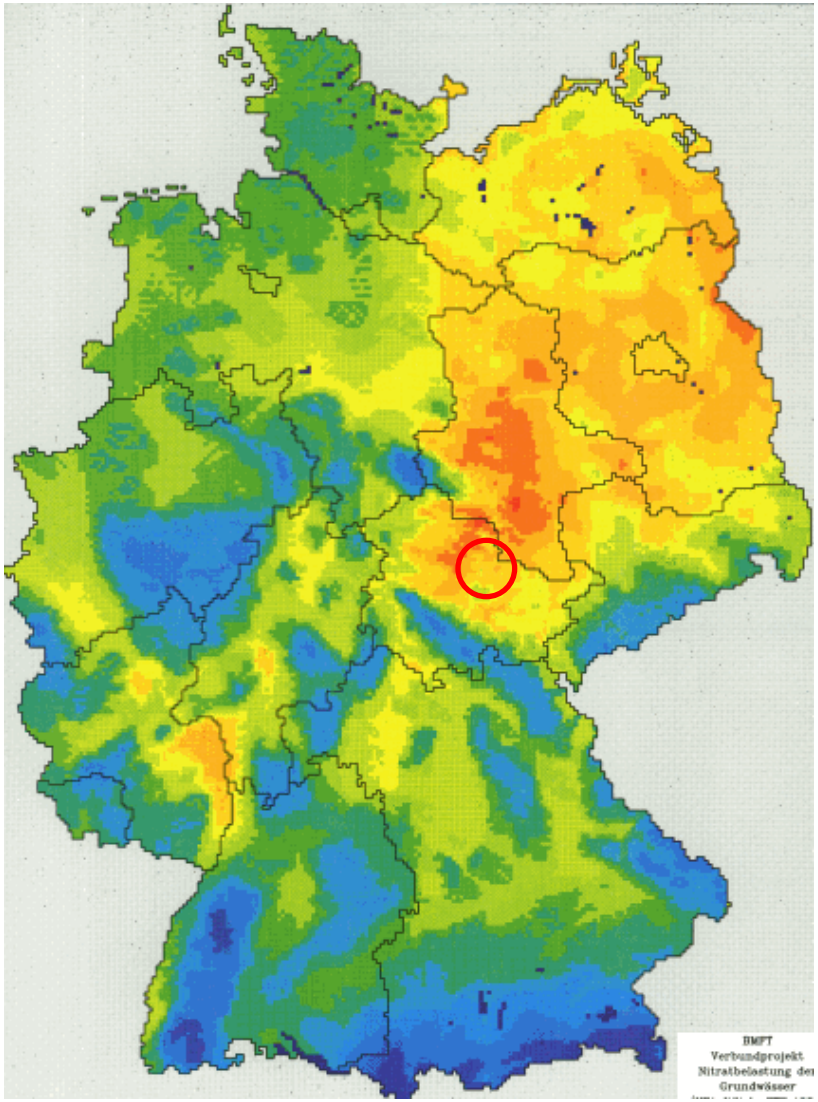
Precipitation



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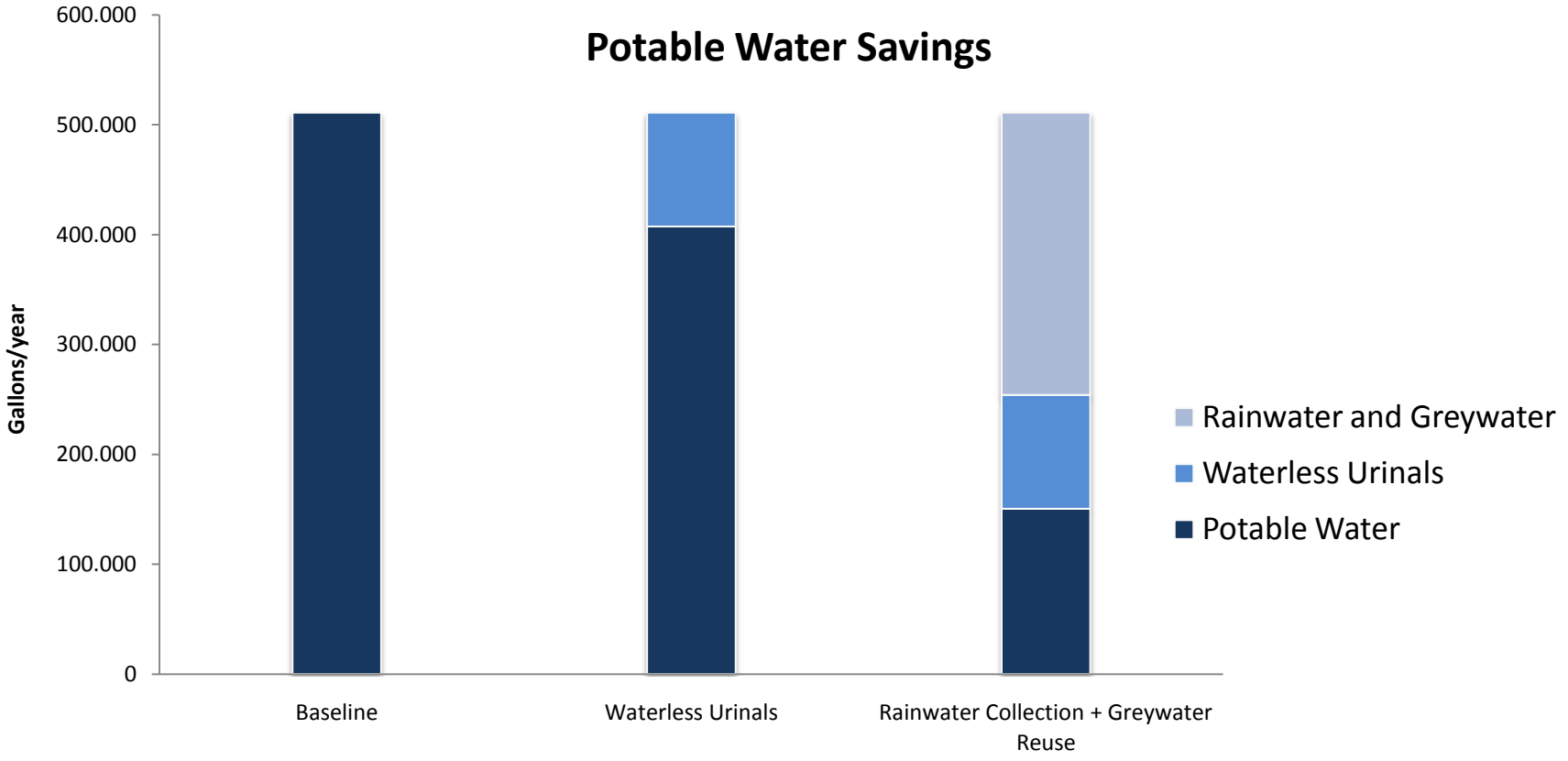
Water Efficiency



Chosen System:
70% reduction
potable water

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LEED

Sustainable Sites	20/26
Water Efficiency	8/8
Energy & Atmosphere	9/35
Materials & Resources	10/14
Indoor Environmental Quality	15/15
Innovation & Design Process	1/6

Total: 63/110

LEED Gold

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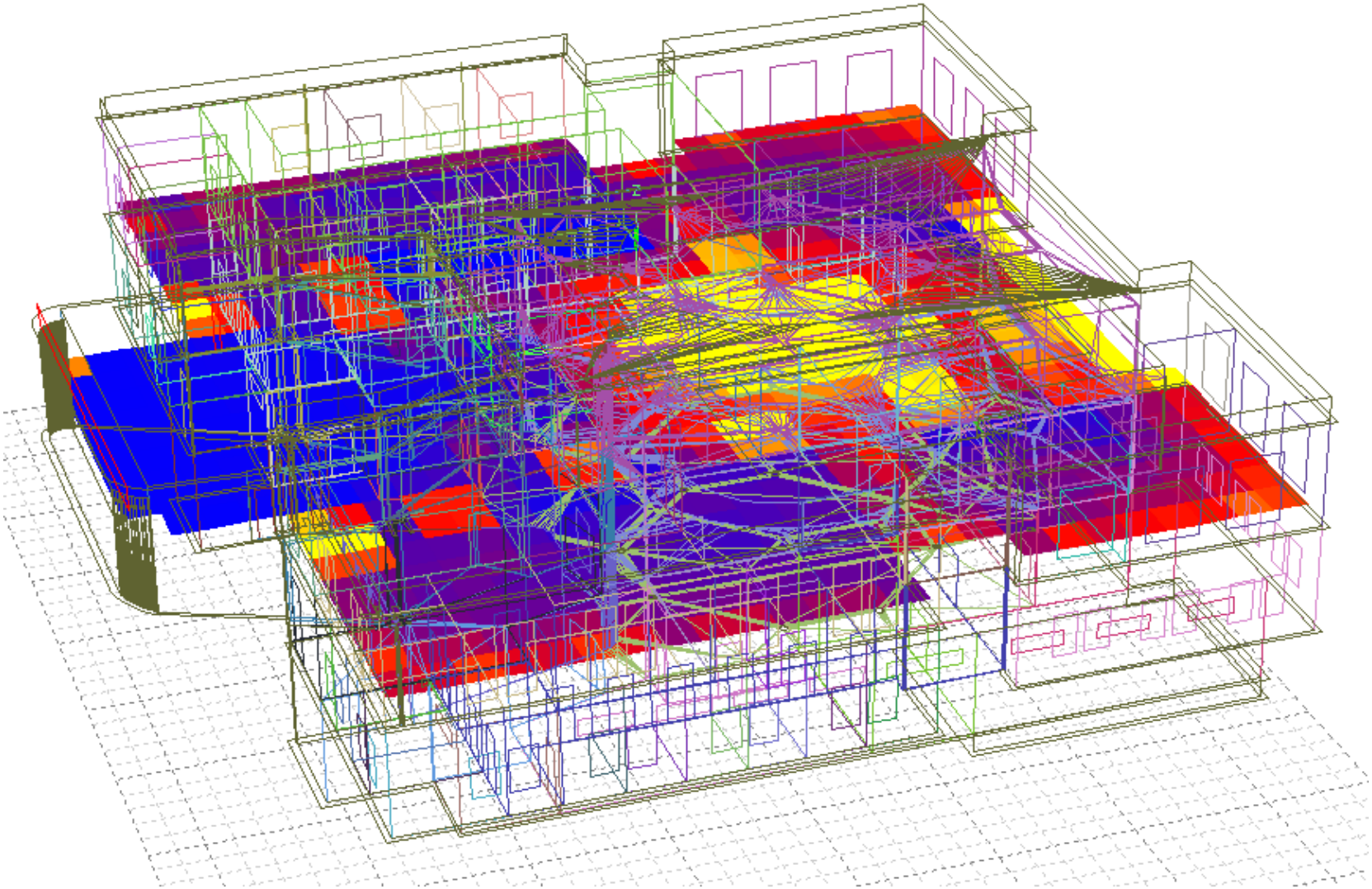

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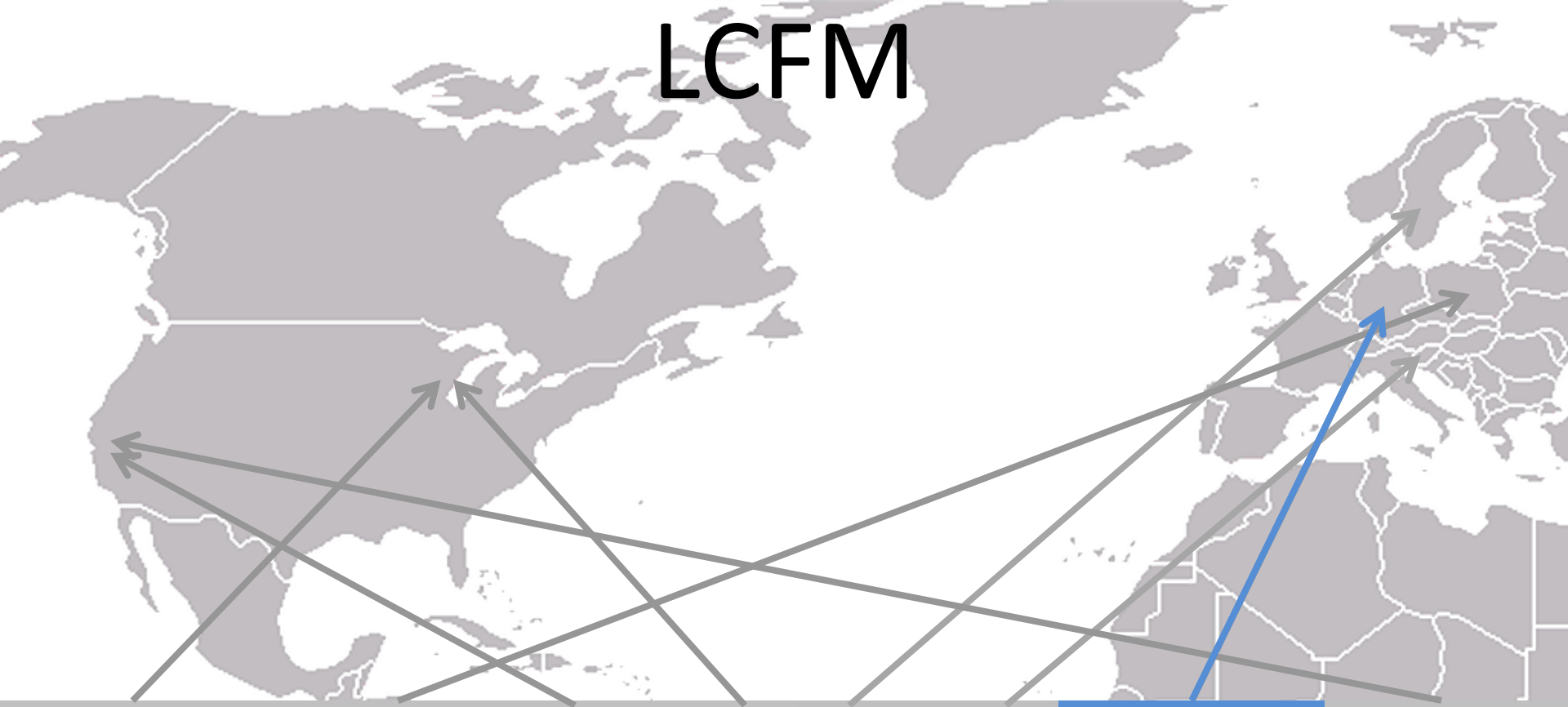
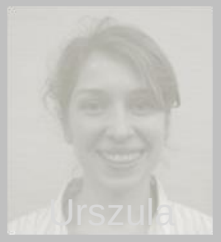
LCFM



Owner | A | E | C | L | S


David


Urszula

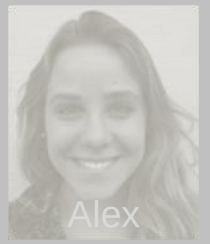

Joanna


Brent

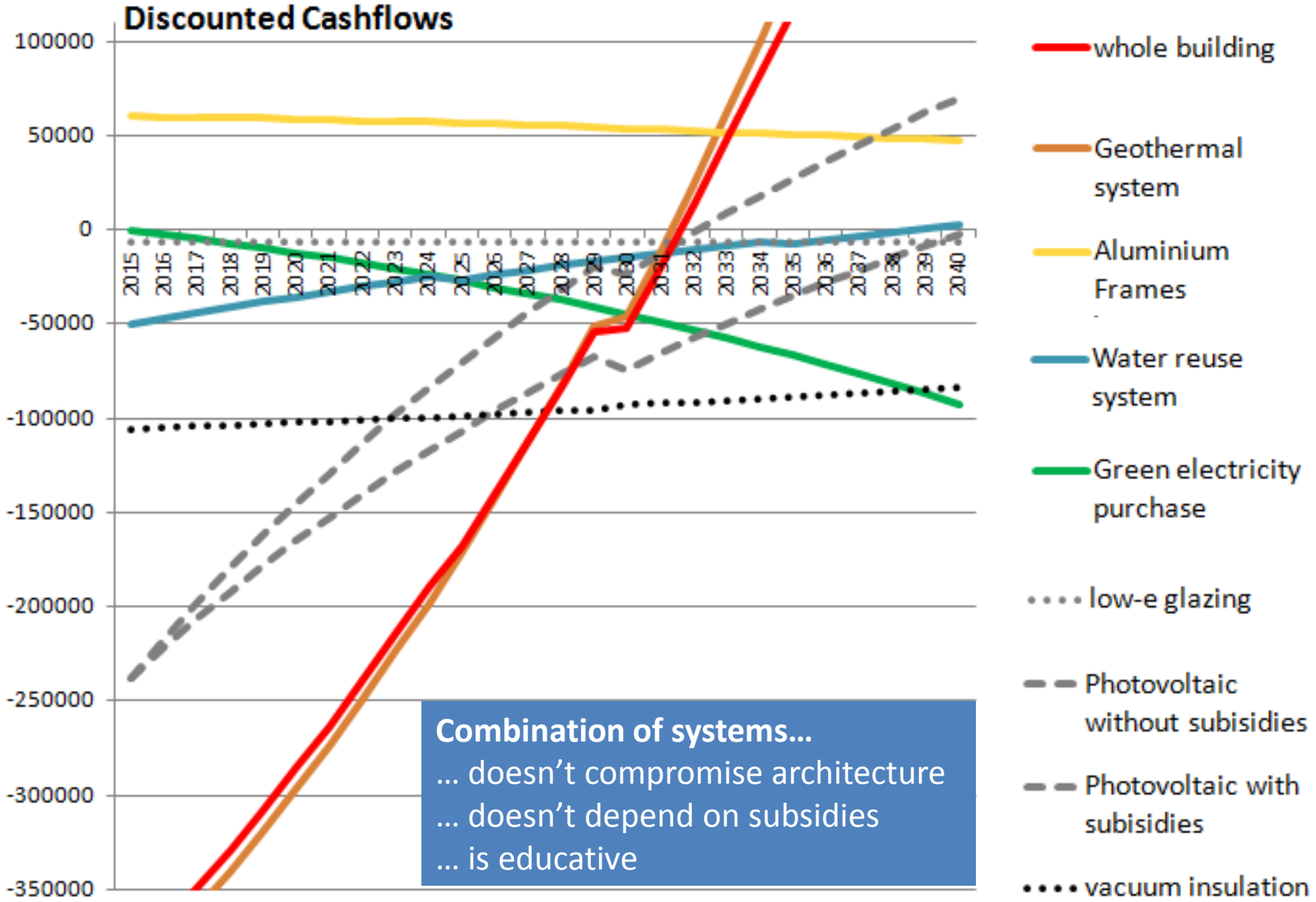

Nima


Martin


Sebastian


Alex

LCC Analysis options and choices



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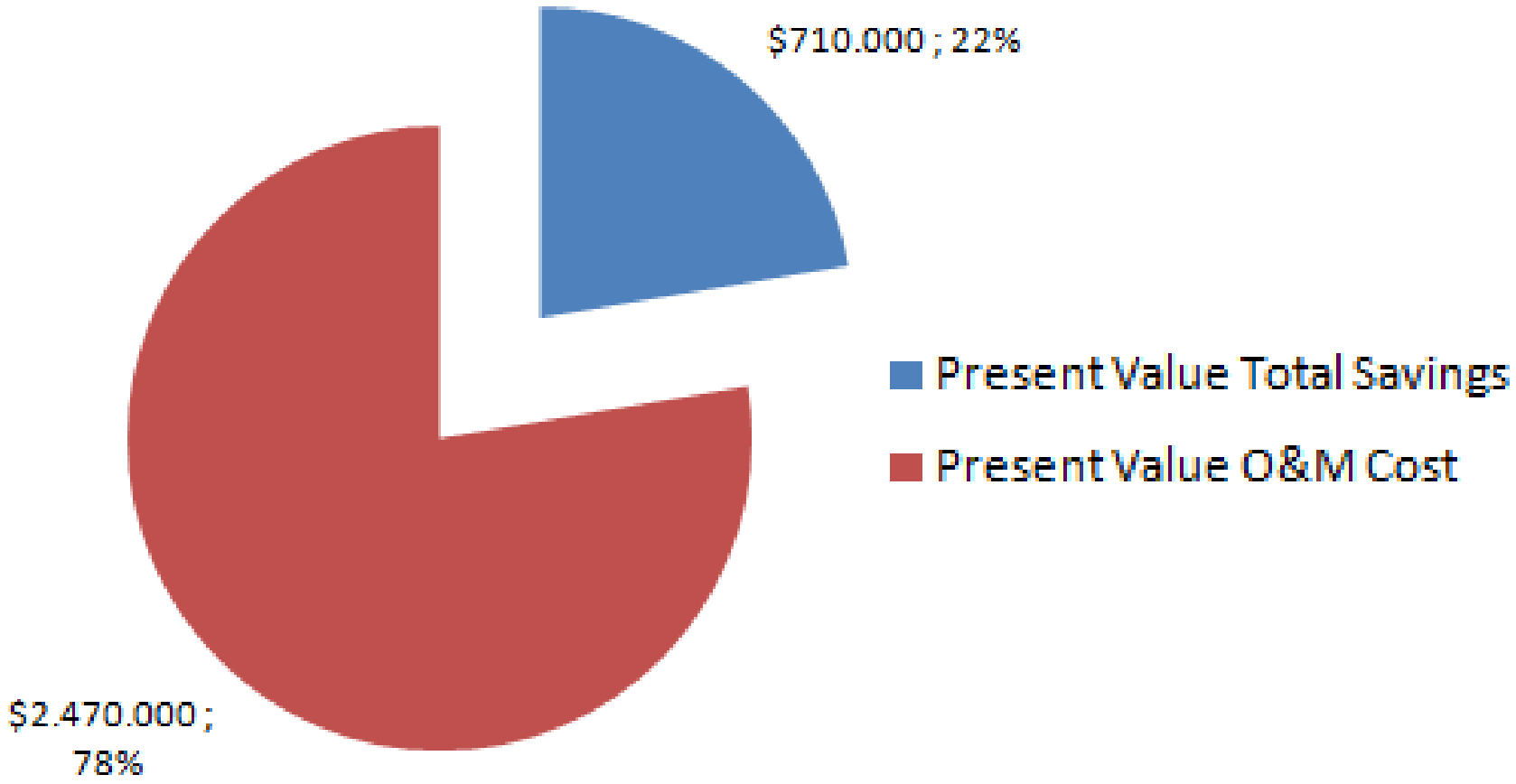
Effect on O&M cost



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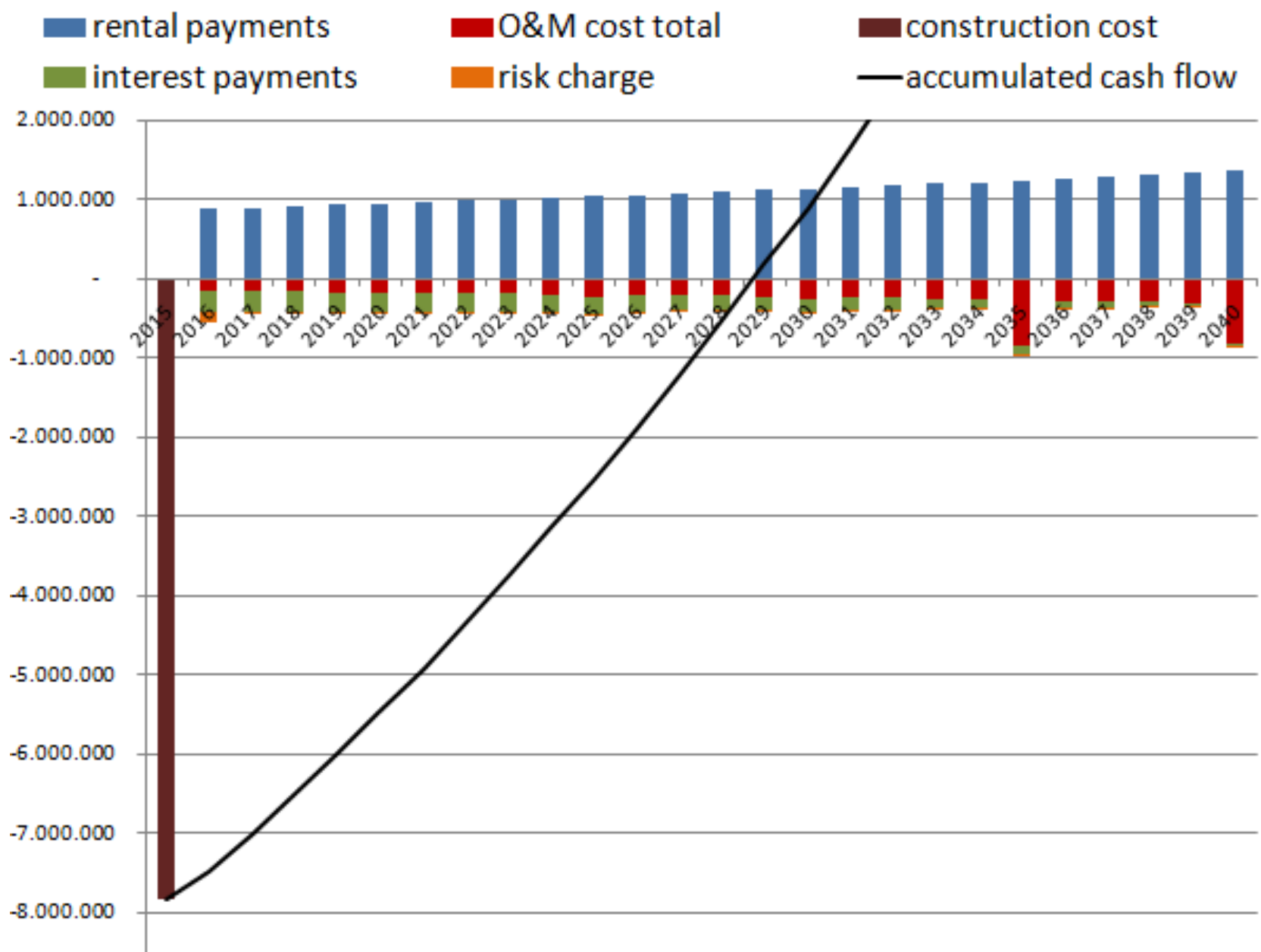
Cash Flow



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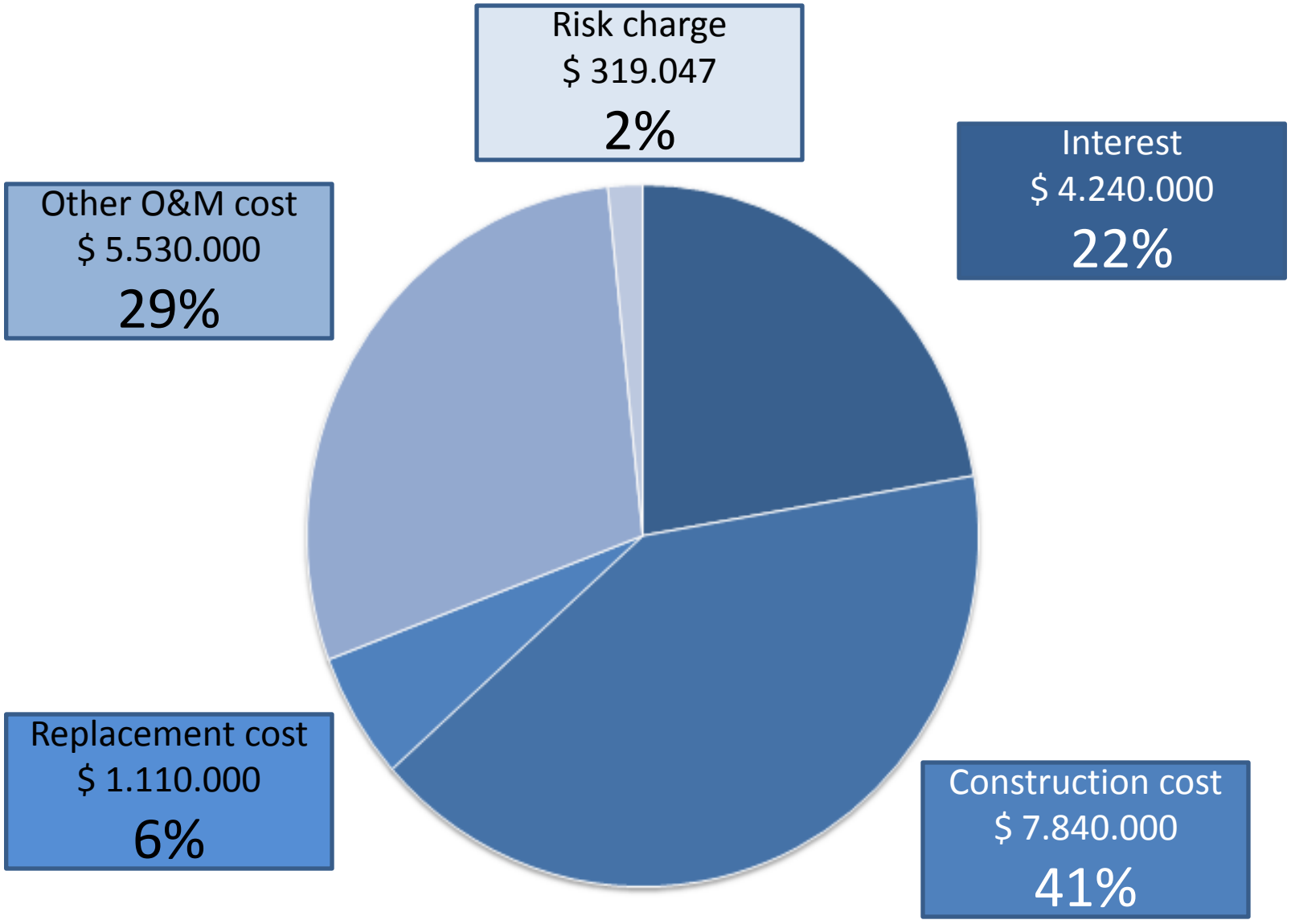
Life Cycle Cost



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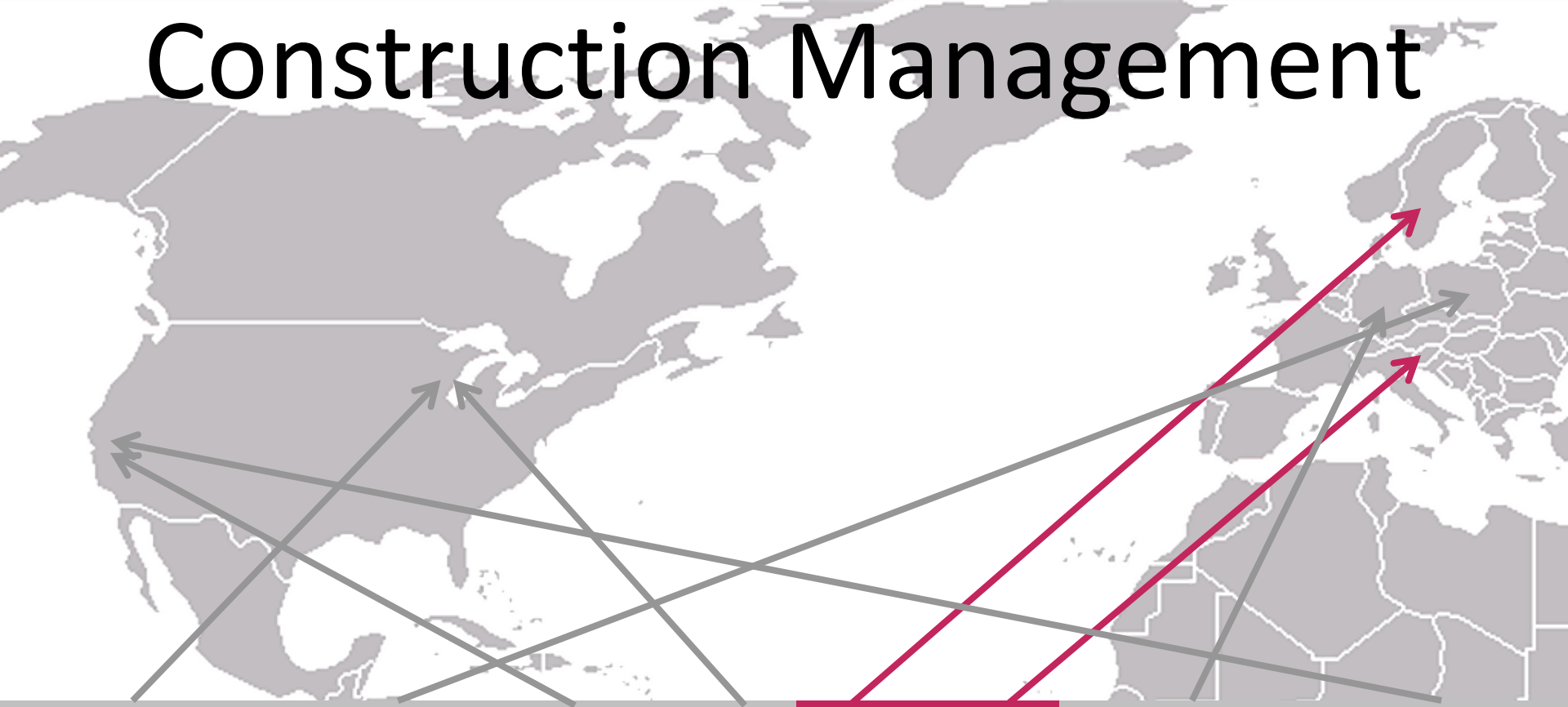
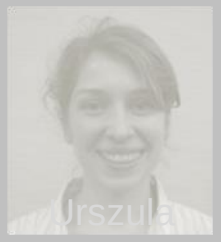
Construction Management



Owner | A | E | C | L | S


David


Urszula

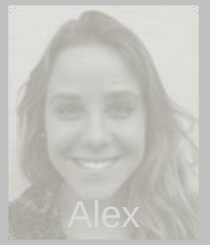

Joanna


Brent

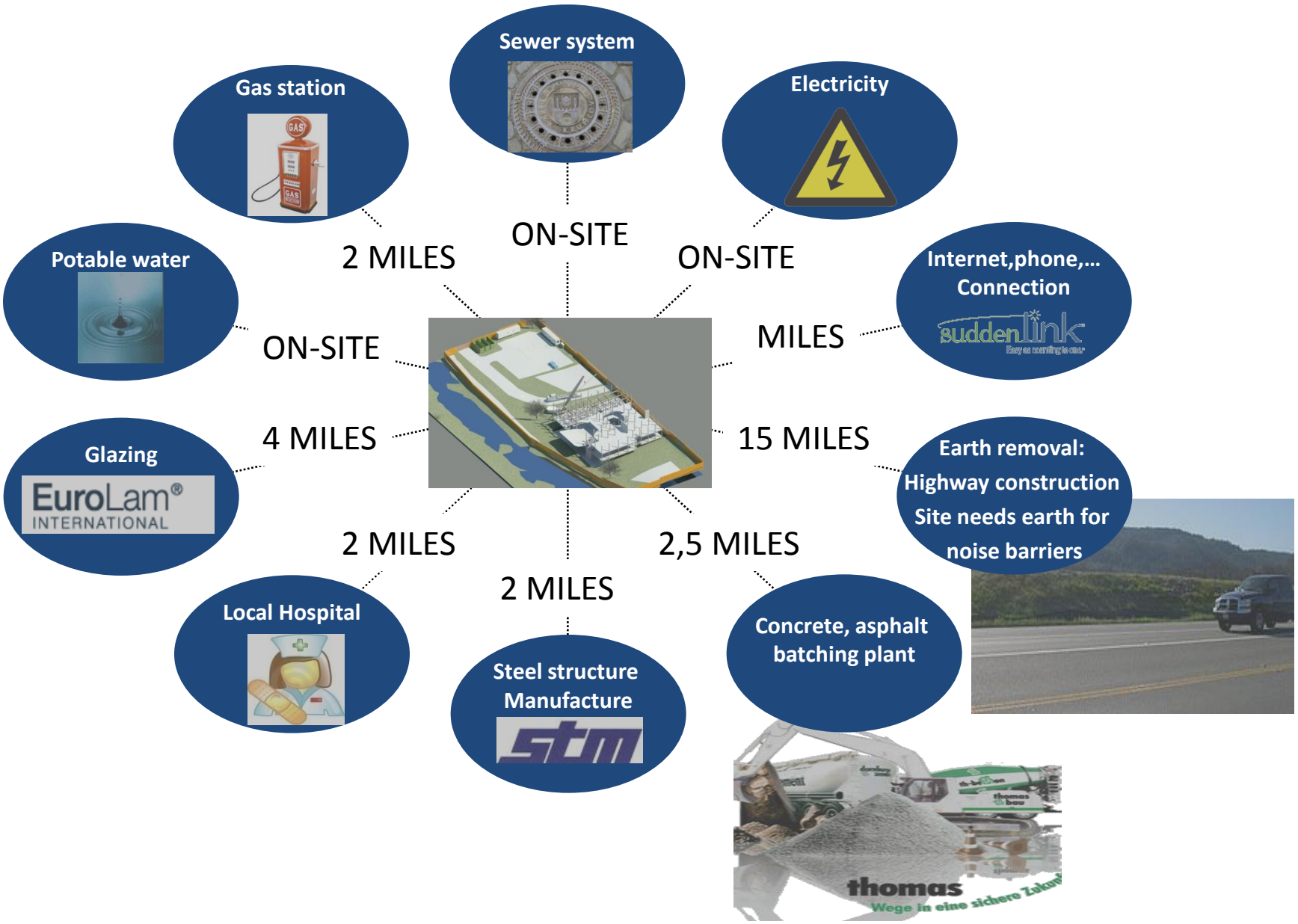

Nima


Martin


Sebastian


Alex

Pre-construction analysis



A E C L S

Construction Methods

- Flood-protecting system during construction
- Sheet piles during excavation
- Dewater
- Similar beam sizes
- No building components greater than 50’
- Special construction
  - Geothermal, horizontally installed
- Just in time delivery

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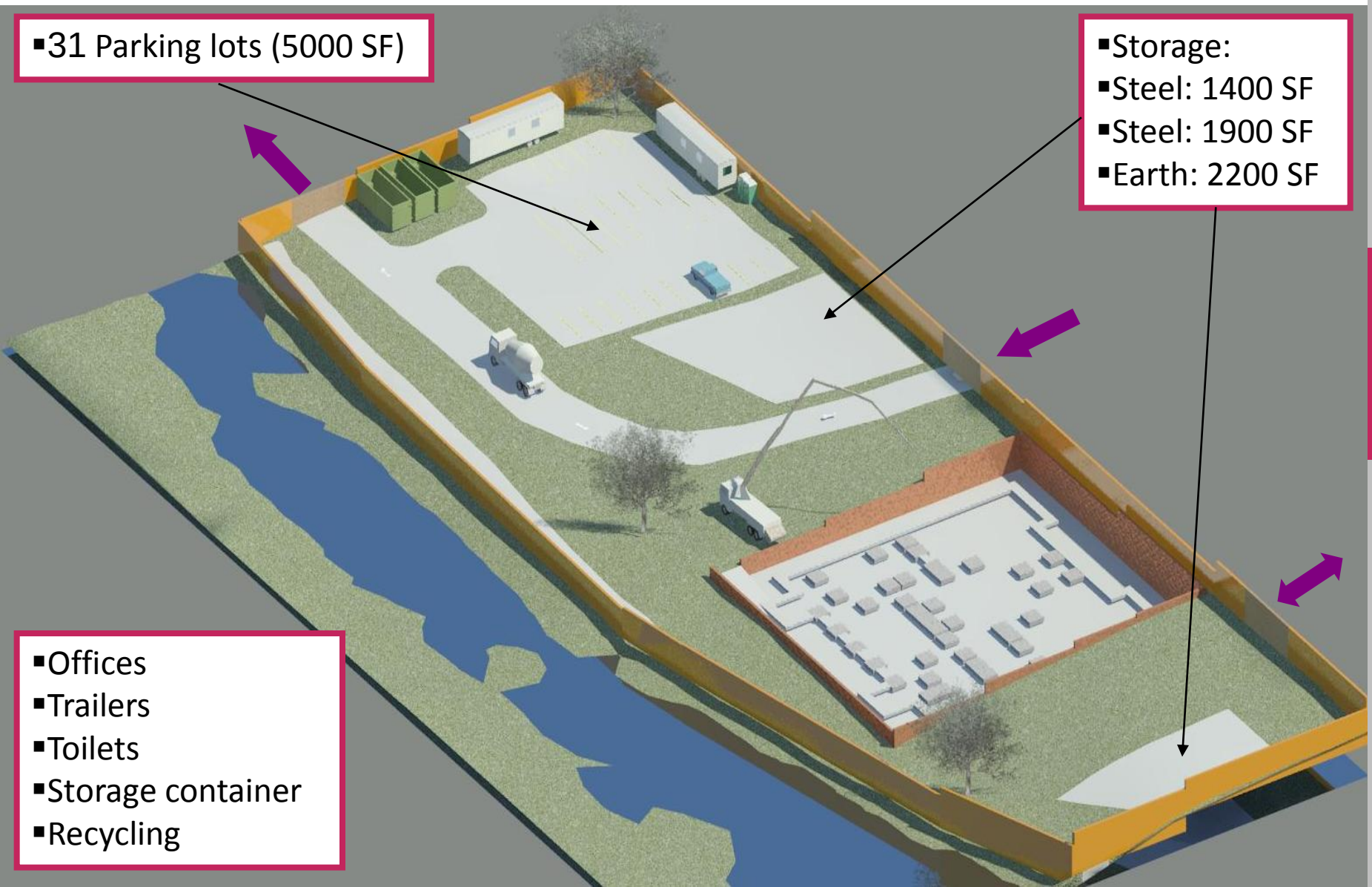
Site Layout - Foundation



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Site Layout - Erection

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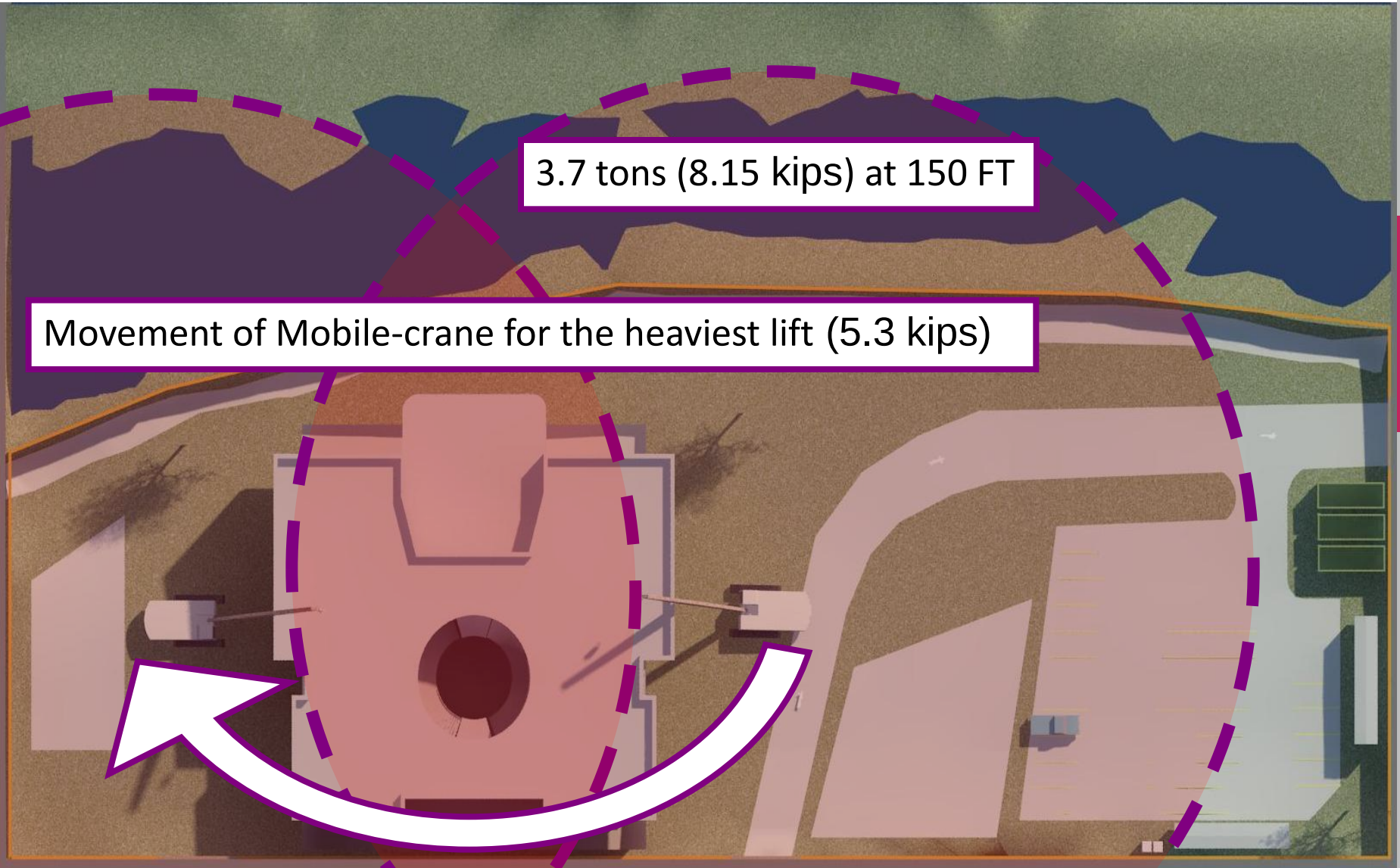
Site Layout – Plan view

Normal Water Level



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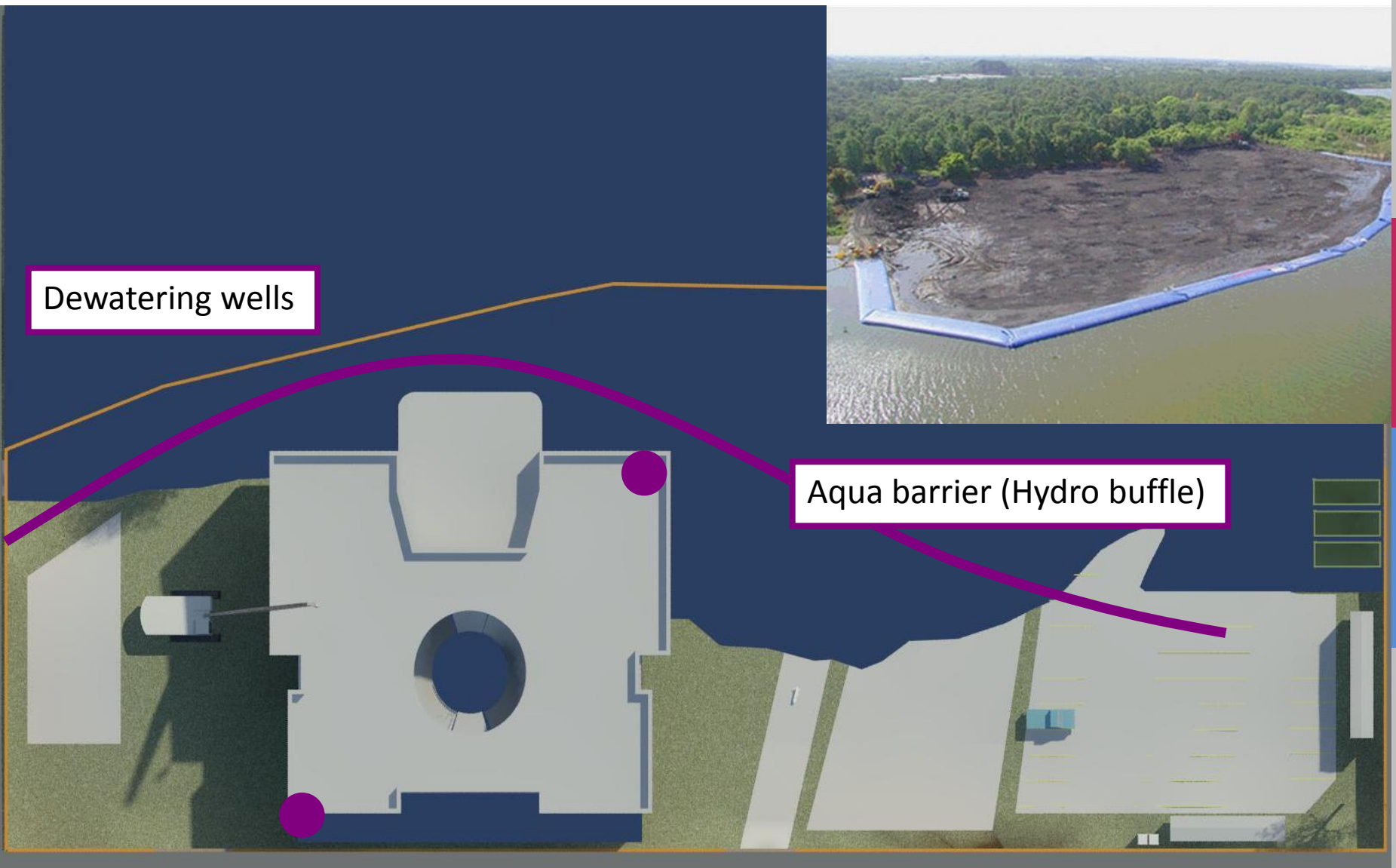
Site Layout

High water level



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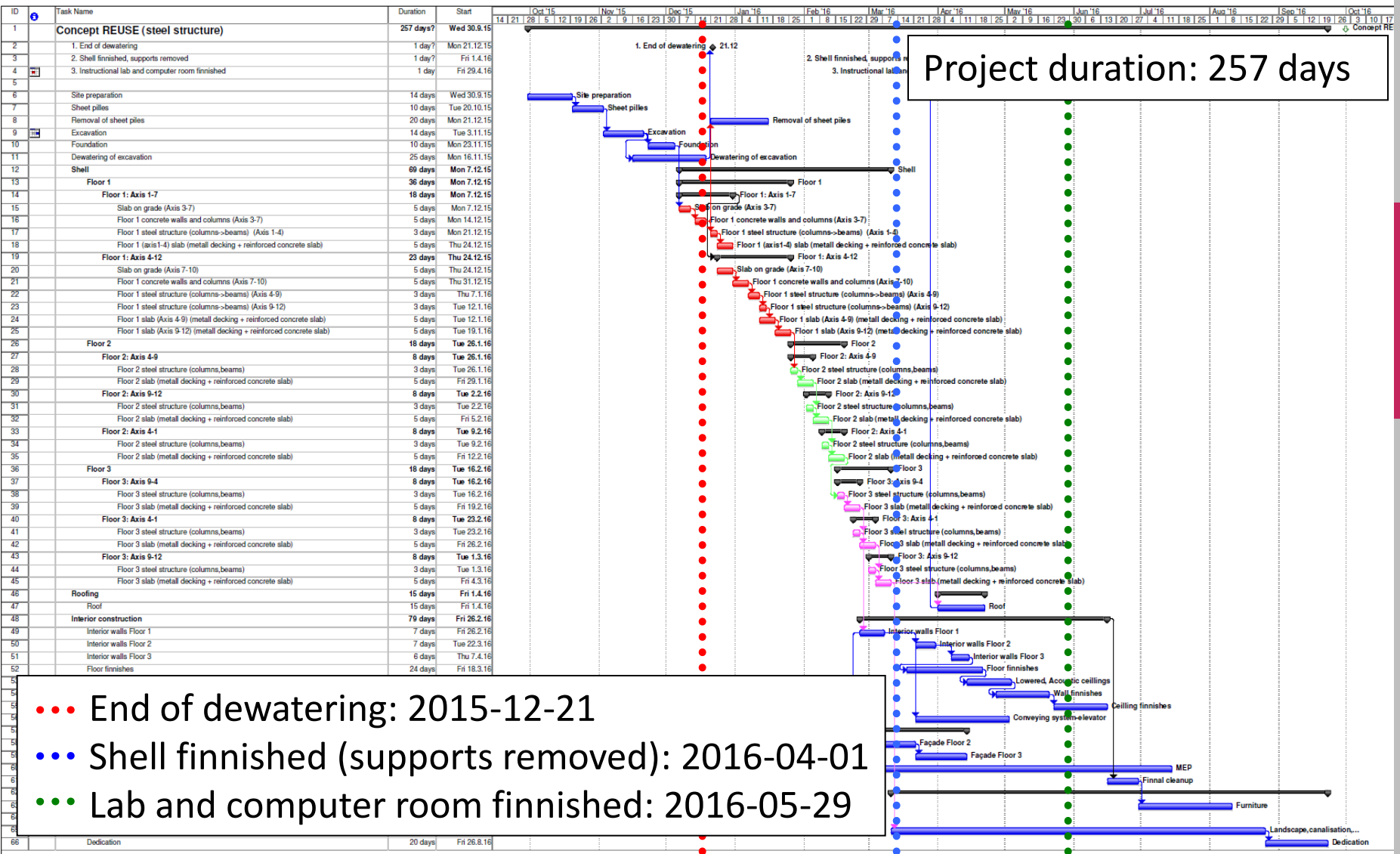
Construction schedule

MS Project schedule optimized with Navisworks

ID	Task Name	Duration	Start
1	**Concept REUSE (steel structure)**	**257 days?**	**Wed 30.9.15**
2	1. End of dewatering	1 day?	Mon 21.12.15
3	2. Shell finnished, supports removed	1 day?	Fri 1.4.16
4	3. Instructional lab and computer room finnished	1 day	Fri 29.4.16
5			
6	Site preparation	14 days	Wed 30.9.15
7	Sheet pilles	10 days	Tue 20.10.15
8	Removal of sheet piles	20 days	Mon 21.12.15
9	Excavation	14 days	Tue 3.11.15
10	Foundation	10 days	Mon 23.11.15
11	Dewatering of excavation	25 days	Mon 16.11.15
12	**Shell**	**69 days**	**Mon 7.12.15**
13	**Floor 1**	**36 days**	**Mon 7.12.15**
14	**Floor 1: Axis 1-7**	**18 days**	**Mon 7.12.15**
15	Slab on grade (Axis 3-7)	5 days	Mon 7.12.15
16	Floor 1 concrete walls and columns (Axis 3-7)	5 days	Mon 14.12.15
17	Floor 1 steel structure (columns->beams) (Axis 1-4)	3 days	Mon 21.12.15
18	Floor 1 (axis1-4) slab (metall decking + reinforced concrete slab)	5 days	Thu 24.12.15
19	**Floor 1: Axis 4-12**	**23 days**	**Thu 24.12.15**
20	Slab on grade (Axis 7-10)	5 days	Thu 24.12.15
21	Floor 1 concrete walls and columns (Axis 7-10)	5 days	Thu 31.12.15
22	Floor 1 steel structure (columns->beams) (Axis 4-9)	3 days	Thu 7.1.16
23	Floor 1 steel structure (columns->beams) (Axis 9-12)	3 days	Tue 12.1.16
24	Floor 1 slab (Axis 4-9) (metall decking + reinforced concrete slab)	5 days	Tue 12.1.16
25	Floor 1 slab (Axis 9-12) (metall decking + reinforced concrete slab)	5 days	Tue 19.1.16
26	**Floor 2**	**18 days**	**Tue 26.1.16**
27	**Floor 2: Axis 4-9**	**8 days**	**Tue 26.1.16**
28	Floor 2 steel structure (columns,beams)	3 days	Tue 26.1.16
29	Floor 2 slab (metall decking + reinforced concrete slab)	5 days	Fri 29.1.16
30	**Floor 2: Axis 9-12**	**8 days**	**Tue 2.2.16**
31	Floor 2 steel structure (columns,beams)	3 days	Tue 2.2.16
32	Floor 2 slab (metall decking + reinforced concrete slab)	5 days	Fri 5.2.16
33	**Floor 2: Axis 4-1**	**8 days**	**Tue 9.2.16**
34	Floor 2 steel structure (columns,beams)	3 days	Tue 9.2.16
35	Floor 2 slab (metall decking + reinforced concrete slab)	5 days	Fri 12.2.16
36	**Floor 3**	**18 days**	**Tue 16.2.16**
37	**Floor 3: Axis 9-4**	**8 days**	**Tue 16.2.16**
38	Floor 3 steel structure (columns,beams)	3 days	Tue 16.2.16
39	Floor 3 slab (metall decking + reinforced concrete slab)	5 days	Fri 19.2.16
40	**Floor 3: Axis 4-1**	**8 days**	**Tue 23.2.16**
41	Floor 3 steel structure (columns,beams)	3 days	Tue 23.2.16
42	Floor 3 slab (metall decking + reinforced concrete slab)	5 days	Fri 26.2.16
43	**Floor 3: Axis 9-12**	**8 days**	**Tue 1.3.16**
44	Floor 3 steel structure (columns,beams)	3 days	Tue 1.3.16
45	Floor 3 slab (metall decking + reinforced concrete slab)	5 days	Fri 4.3.16
46	**Roofing**	**15 days**	**Fri 1.4.16**
47	Roof	15 days	Fri 1.4.16
48	**Interior construction**	**79 days**	**Fri 26.2.16**
49	Interior walls Floor 1	7 days	Fri 26.2.16
50	Interior walls Floor 2	7 days	Tue 22.3.16
51	Interior walls Floor 3	6 days	Thu 7.4.16
52	Floor finnishes	24 days	Fri 18.3.16
66	Dedication	20 days	Fri 26.8.16

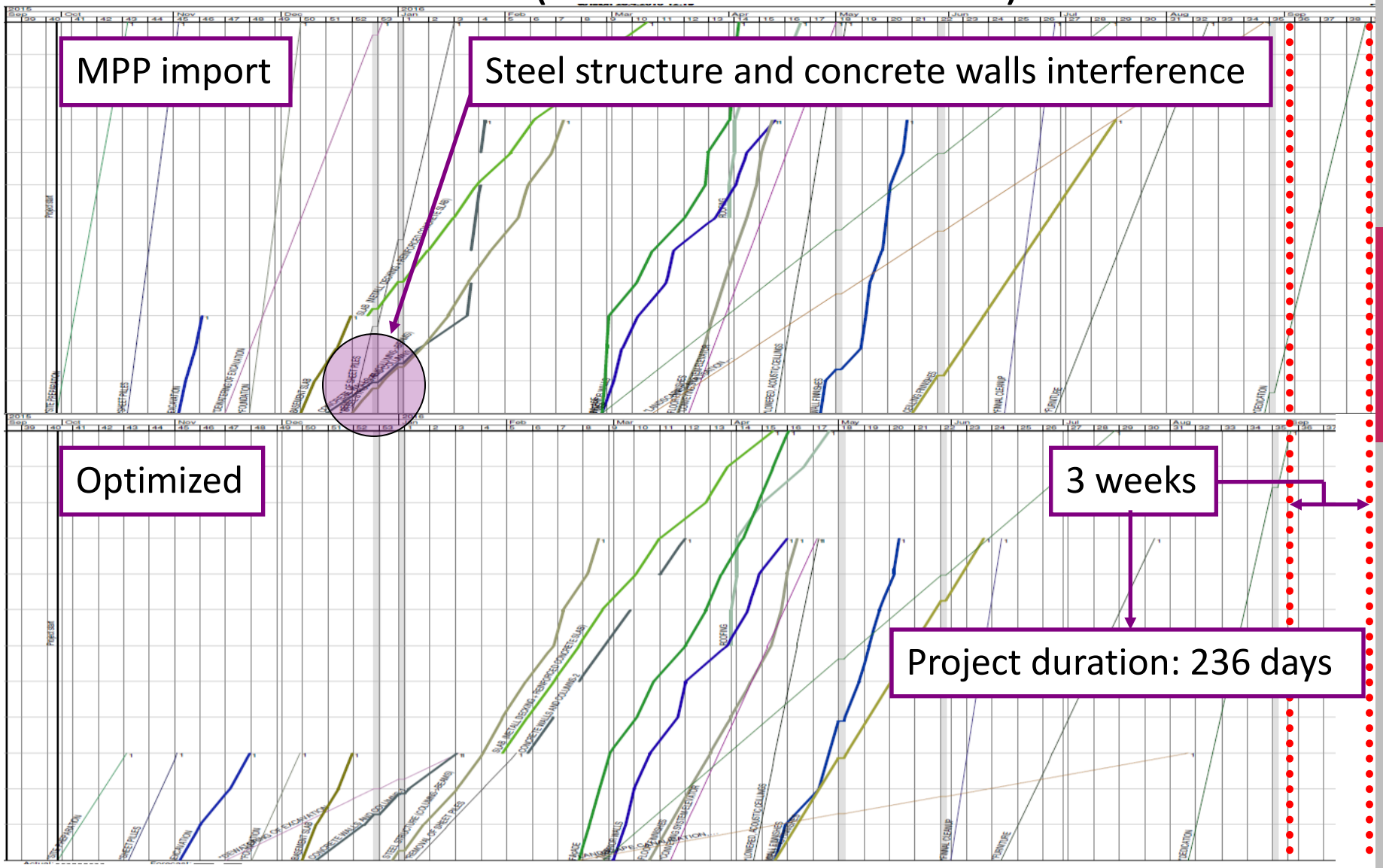


- End of dewatering: 2015-12-21
- Shell finnished (supports removed): 2016-04-01
- Lab and computer room finnished: 2016-05-29

A E C L S

Construction schedule

Model-based schedule (VICO Software 2008)



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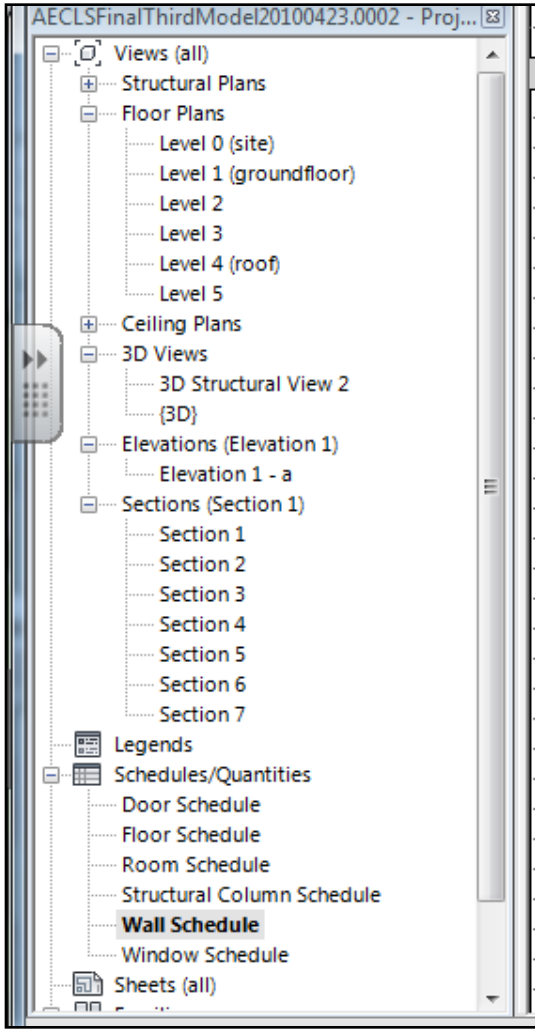
Model based cost estimate

Revit → Excel

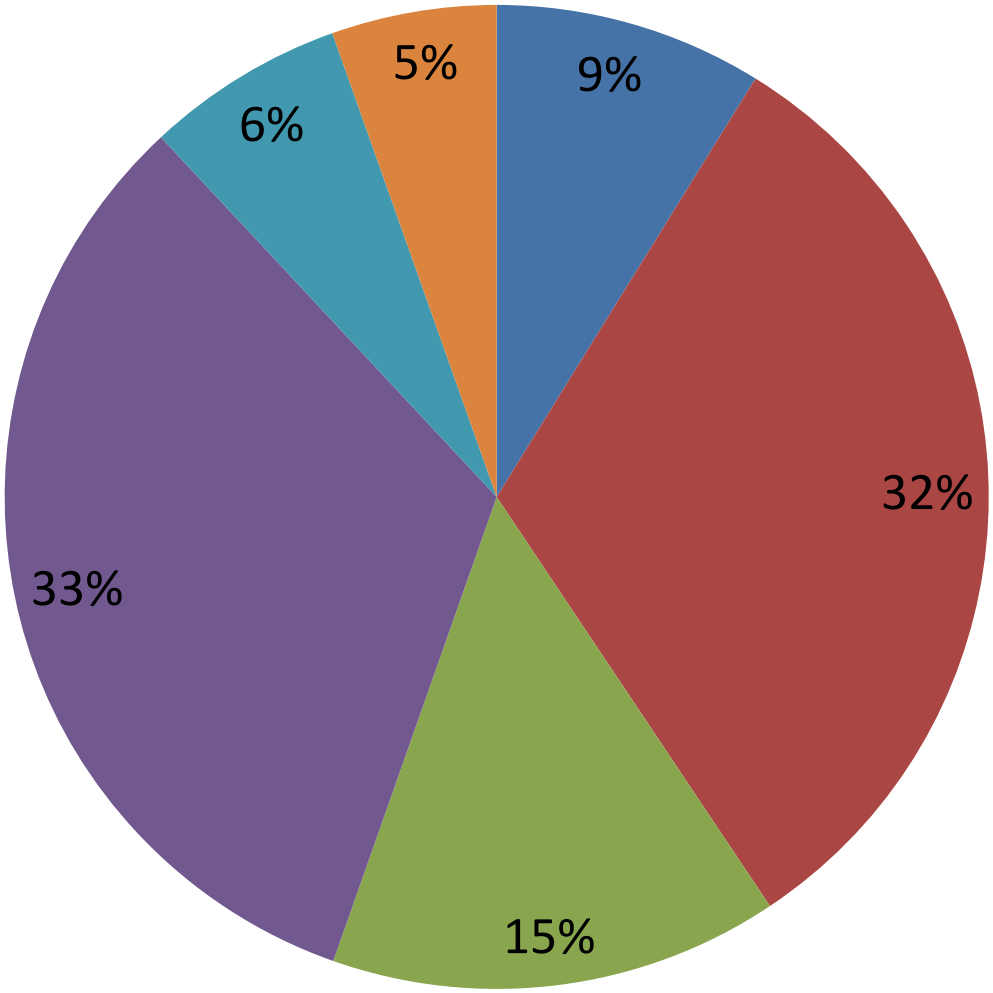


Wall Schedule

Type	Area	Family	Length	Width	Cost	AreaAmount	TotoalCost
Wall exterior	631.79 SF	Basic Wal	48' - 11"	1' - 5"	48.60	631.791821	30705.08249
Shear Wall	84.38 SF	Basic Wal	6' - 3"	1' - 5"	1.00	84.375	84.375
Wall exterior	311.94 SF	Basic Wal	24' - 10 1/2"	1' - 5"	48.60	311.943609	15160.45941
Wall exterior	165.71 SF	Basic Wal	12' - 6"	1' - 5"	48.60	165.708463	8053.431319
Wall exterior	184.34 SF	Basic Wal	13' - 6"	1' - 5"	48.60	184.33936	8958.892909
Wall exterior	136.79 SF	Basic Wal	12' - 6"	1' - 5"	48.60	136.786891	6647.842897
Wall exterior	591.68 SF	Basic Wal	49' - 0"	1' - 5"	48.60	591.67942	28755.61979
Wall exterior	158.77 SF	Basic Wal	12' - 6"	1' - 5"	48.60	158.772813	7716.358689
Wall exterior	182.48 SF	Basic Wal	13' - 6"	1' - 5"	48.60	182.480315	8868.543307
Wall exterior	168.75 SF	Basic Wal	12' - 6"	1' - 5"	48.60	168.750542	8201.276329
Wall exterior	139.45 SF	Basic Wal	11' - 9"	1' - 5"	48.60	139.445512	6777.051894
Wall exterior	1245.52 SF	Basic Wal	98' - 7"	1' - 5"	48.60	1245.520376	60532.29027
Wall exterior	335.33 SF	Basic Wal	24' - 10"	1' - 5"	48.60	335.329724	16297.02460
Shear Wall	60.73 SF	Basic Wal	6' - 3"	1' - 5"	1.00	60.725462	60.725462
Wall exterior	93.90 SF	Basic Wal	6' - 3"	1' - 5"	48.60	93.897638	4563.425197
Wall exterior	468.22 SF	Basic Wal	44' - 1"	1' - 5"	48.60	468.218377	22755.41311
Wall exterior	720.41 SF	Basic Wal	61' - 11 1/2"	1' - 5"	48.60	720.413692	35012.10544
Wall exterior	425.02 SF	Basic Wal	36' - 11 1/2"	1' - 5"	48.60	425.022452	20656.09115
Wall exterior	411.08 SF	Basic Wal	37' - 4"	1' - 5"	48.60	411.079538	19978.46556
Shear Wall	74.85 SF	Basic Wal	6' - 3"	1' - 5"	1.00	74.852362	74.852362
Wall exterior	132.73 SF	Basic Wal	9' - 10 1/2"	1' - 5"	48.60	132.73145	6450.748464
Wall interior	439.19 SF	Basic Wal	36' - 9 1/2"	0' - 5 1/2"	9.02	439.189951	3961.493357
Wall interior	162.55 SF	Basic Wal	12' - 3"	0' - 5 1/2"	9.02	162.549213	1466.193898
Wall interior	297.44 SF	Basic Wal	24' - 6 1/2"	0' - 5 1/2"	9.02	297.437005	2682.881788
Wall interior	143.30 SF	Basic Wal	12' - 7 1/2"	0' - 5 1/2"	9.02	143.303147	1292.594386
Wall interior	226.56 SF	Basic Wal	18' - 10"	0' - 5 1/2"	9.02	226.562005	2043.589288
Wall interior	172.96 SF	Basic Wal	12' - 7"	0' - 5 1/2"	9.02	172.957673	1560.078207
Wall interior	275.51 SF	Basic Wal	19' - 8"	0' - 5 1/2"	9.02	275.513454	2485.131356
Wall interior	168.75 SF	Basic Wal	12' - 6"	0' - 5 1/2"	9.02	168.75	1522.125
Wall interior	42.05 SF	Basic Wal	4' - 8"	0' - 5 1/2"	9.02	42.053147	379.319386
Wall interior	129.37 SF	Basic Wal	12' - 8 1/2"	0' - 5 1/2"	9.02	129.372042	1166.93582

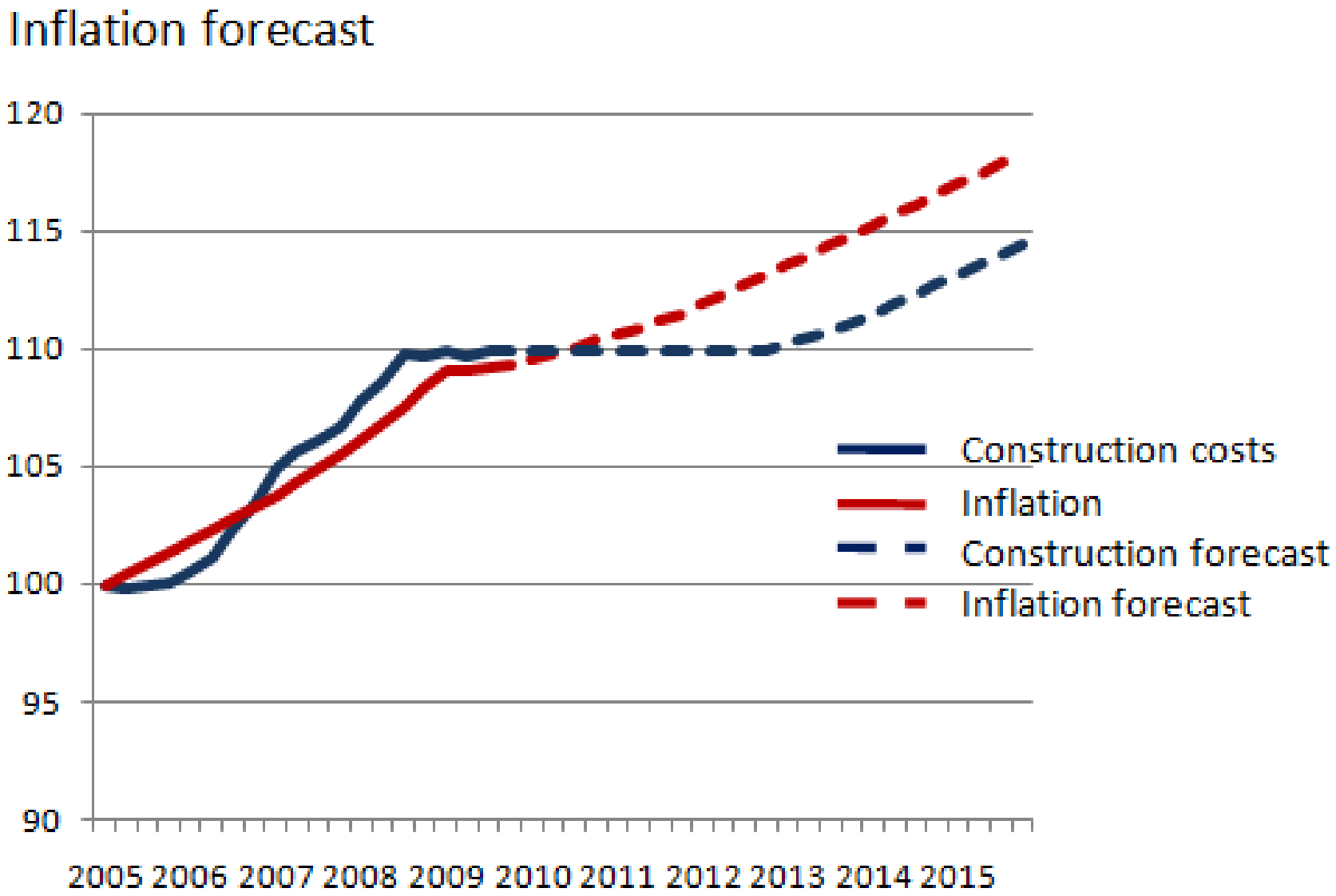
Cost estimate

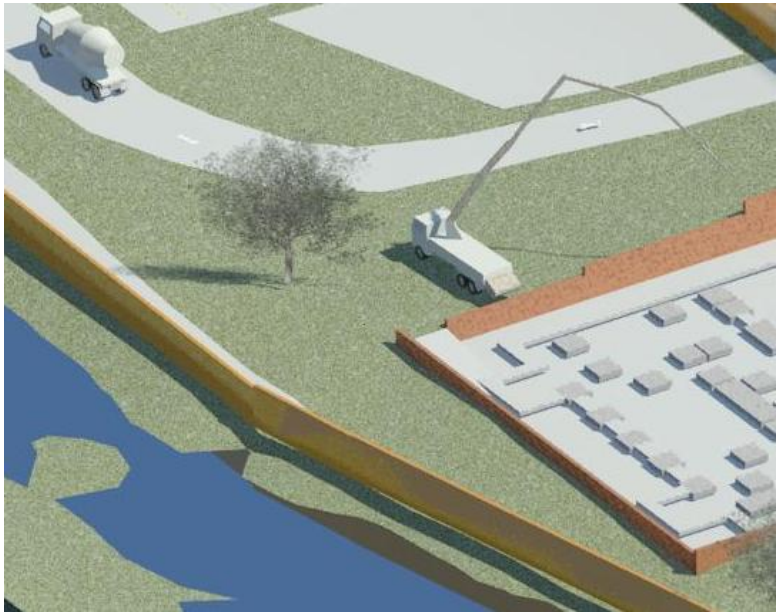
Allocation of costs

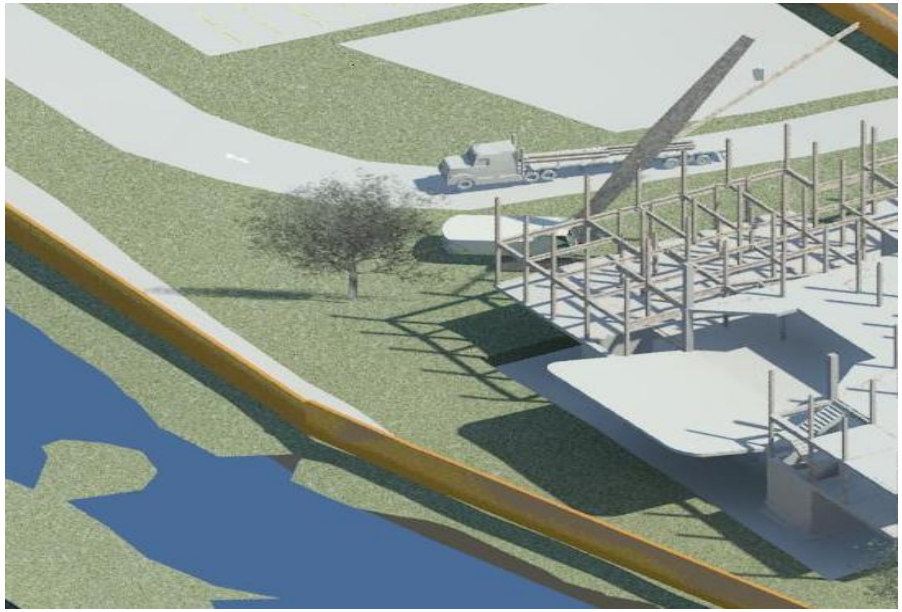


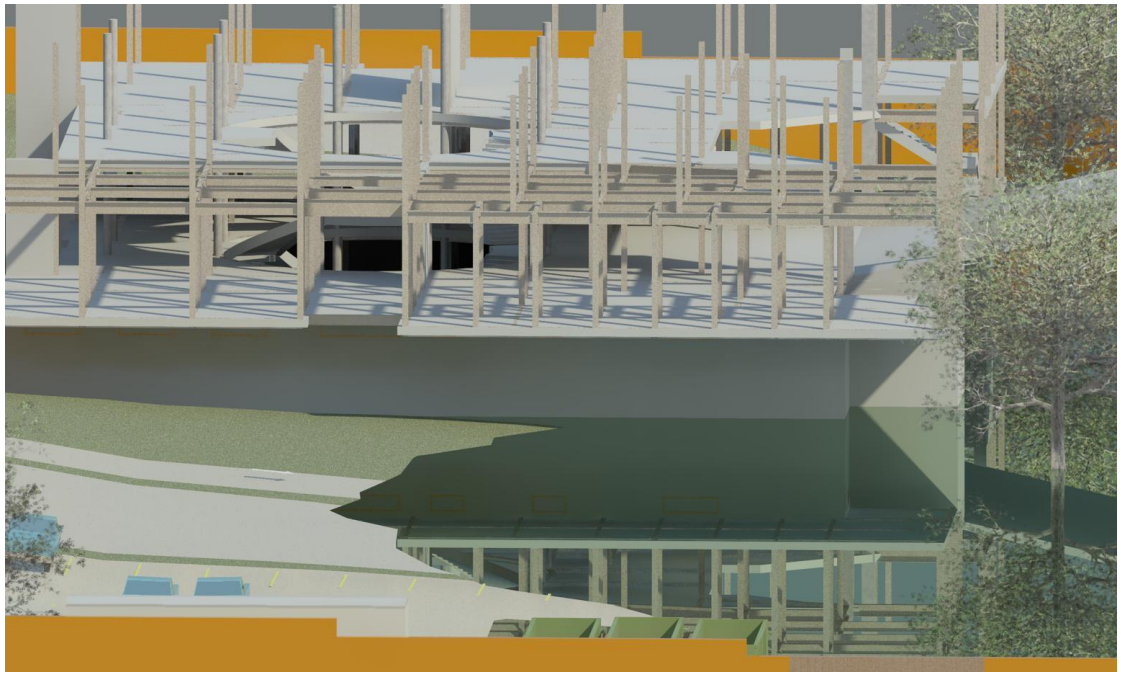
Substructure	$675 000
Shell	$2 435 000
Interiors	$1 130 000
Services	$2 500 000
Sitework	$500 000
Other	$415 000
Total	$7 655 000

Cost estimate









A

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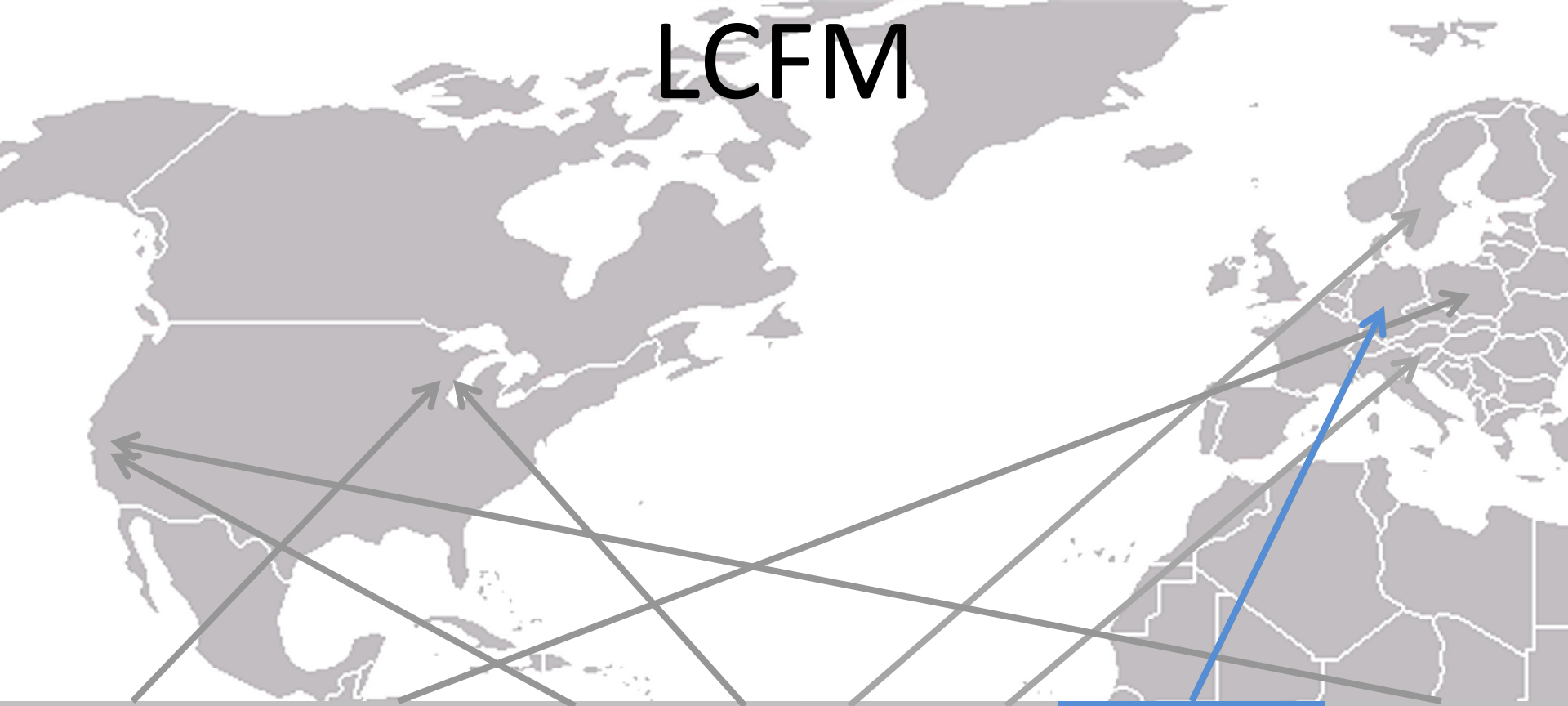
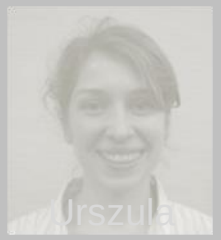
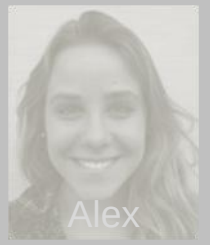
LCFM



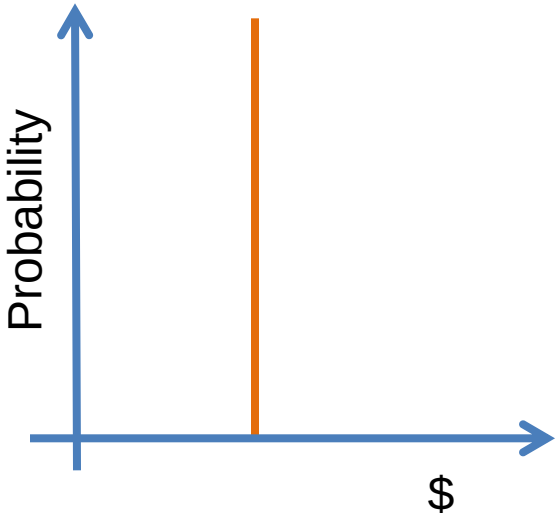
Owner | A | E | C | L | S



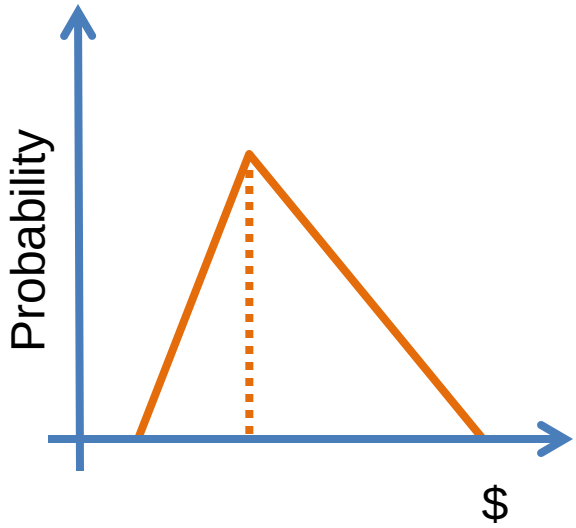


Risk Management

From
certain costs

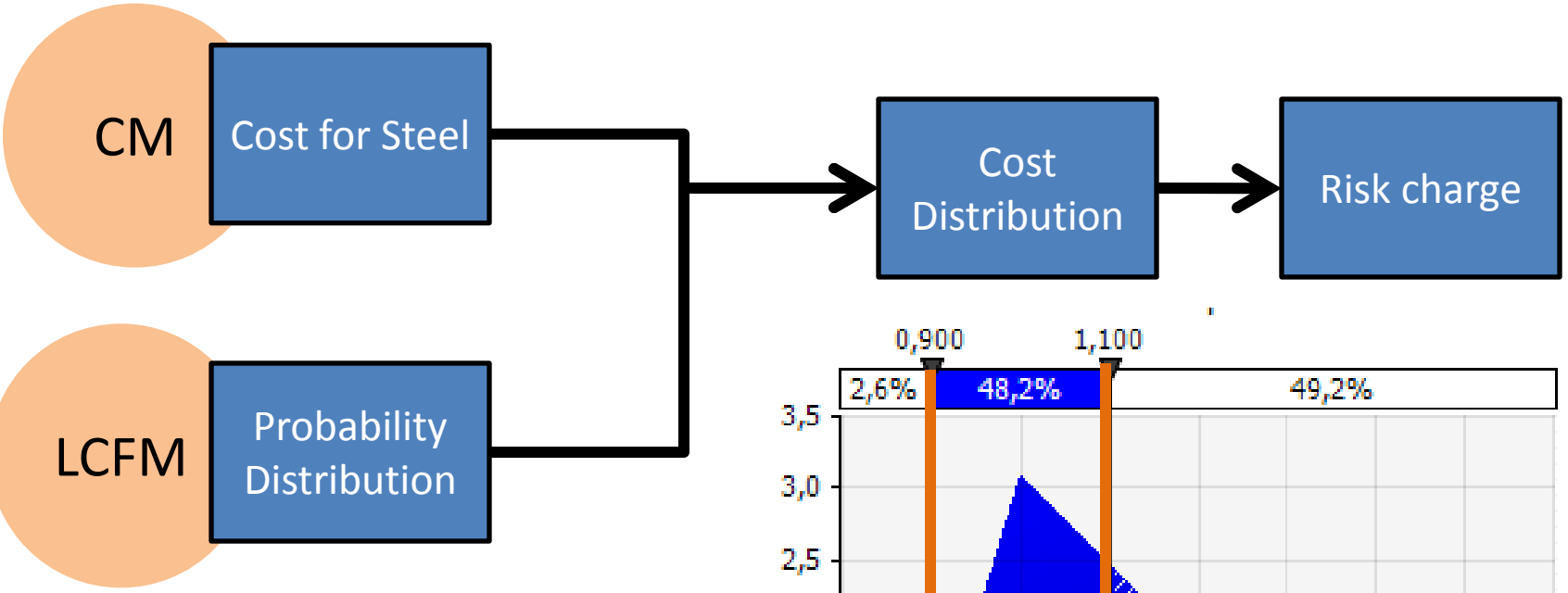


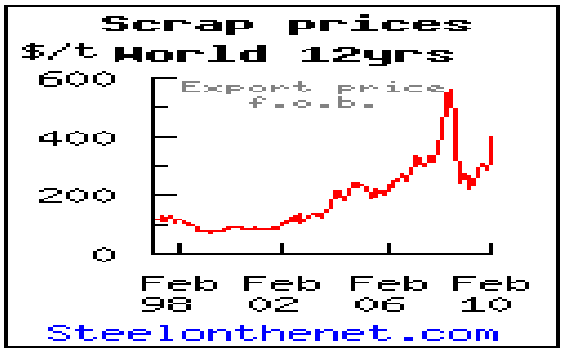
To
uncertain costs

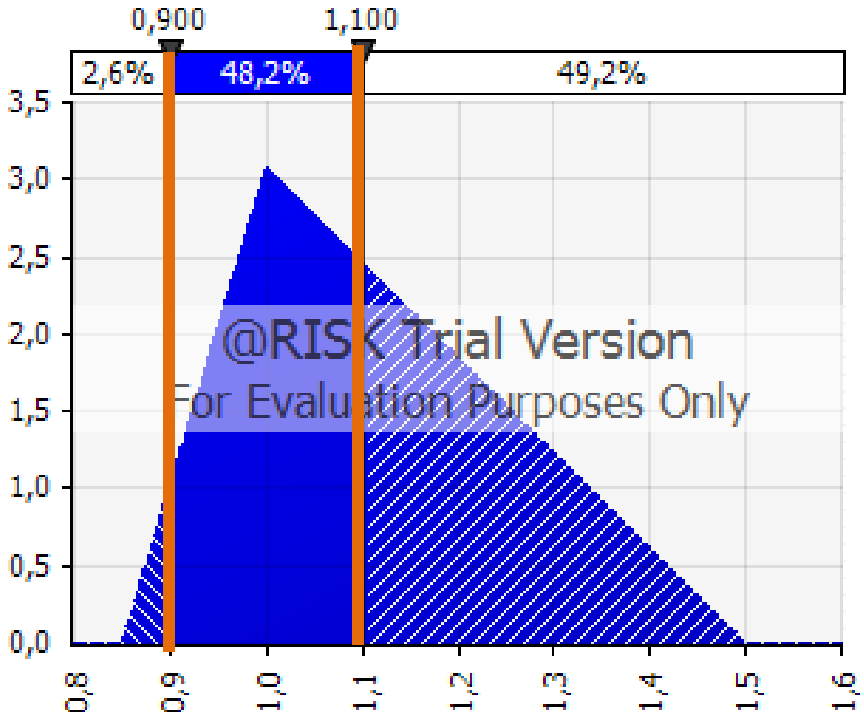


Risk Management

Example Steel price

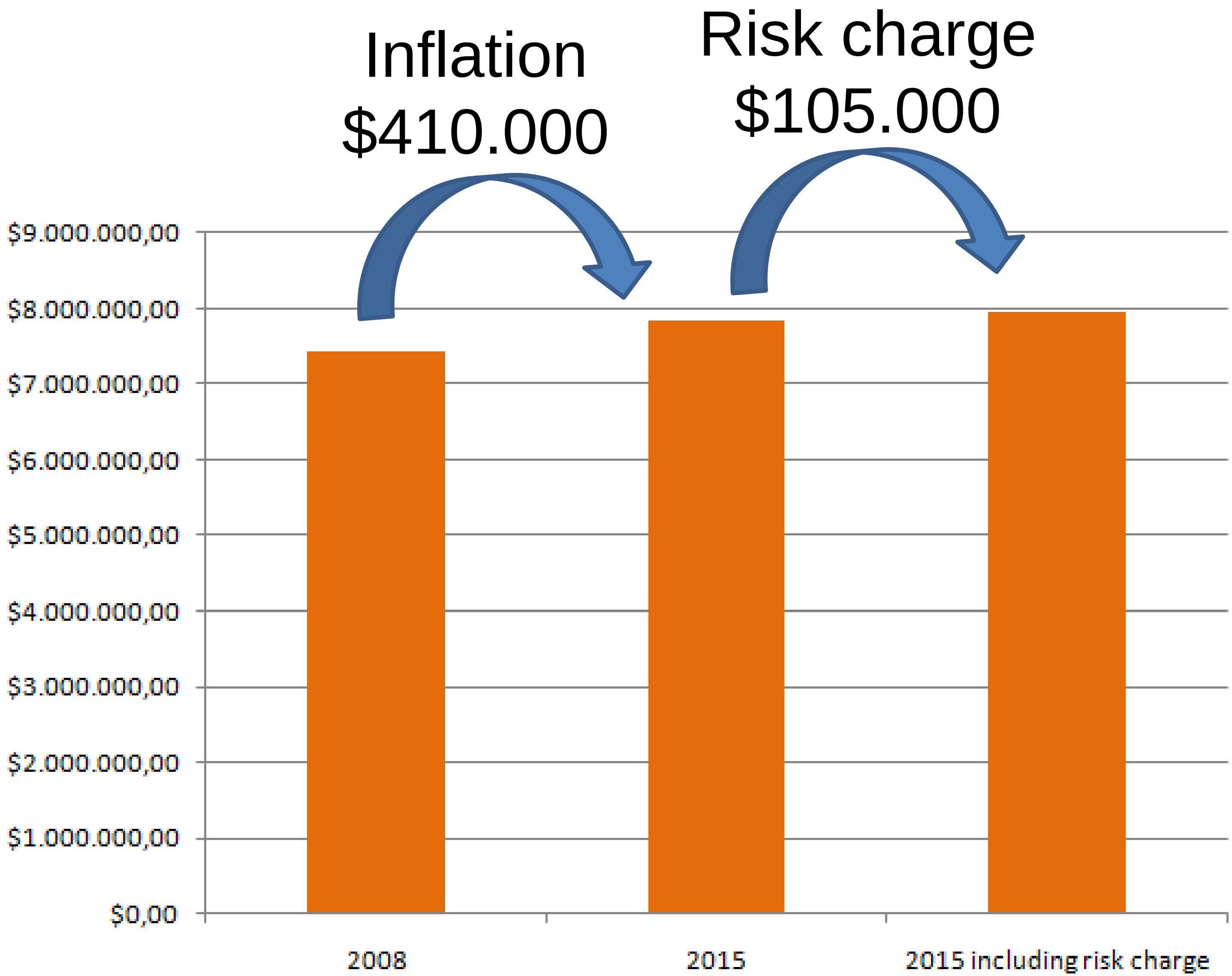




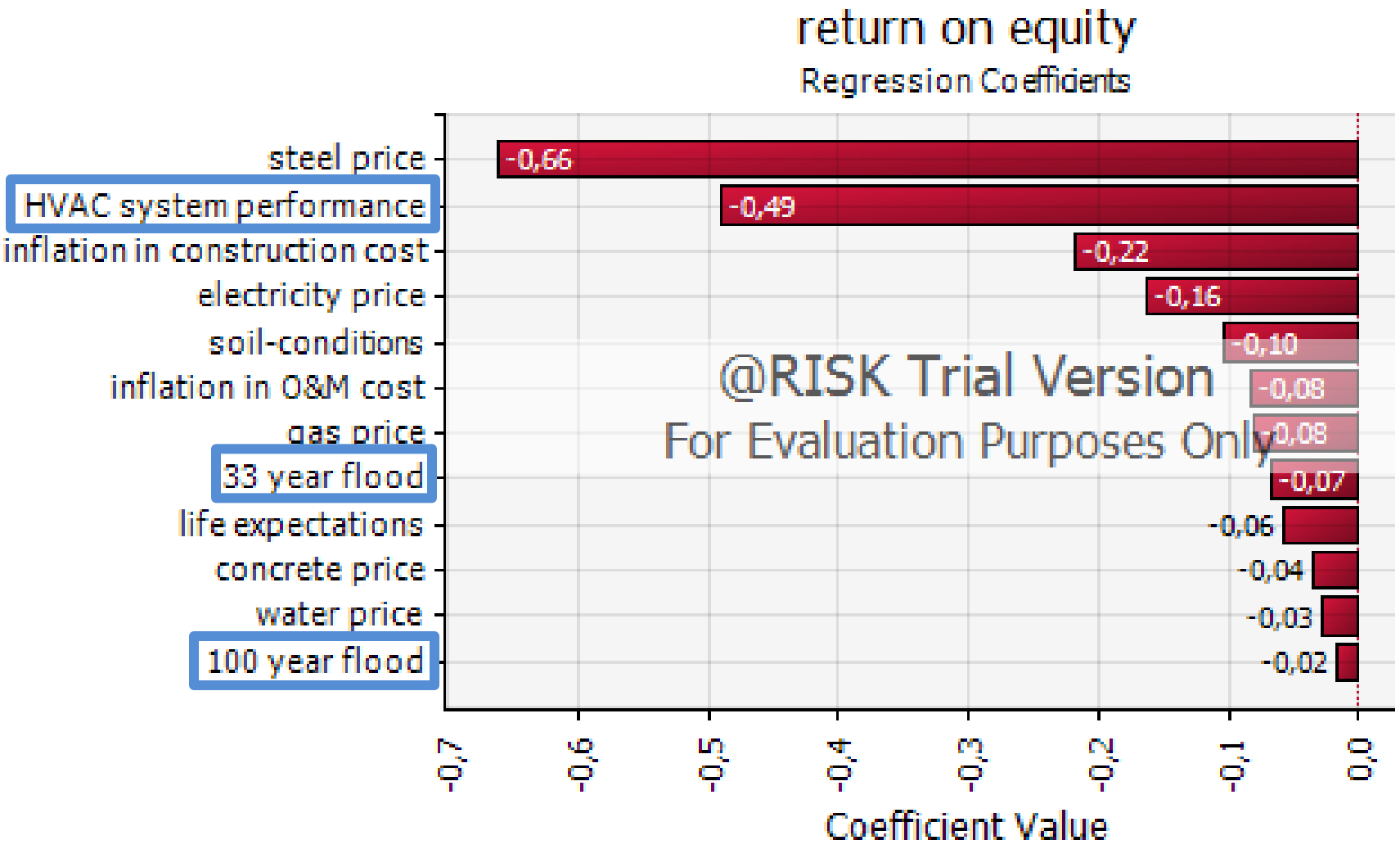


A E C L S

Construction Cost Adjustments

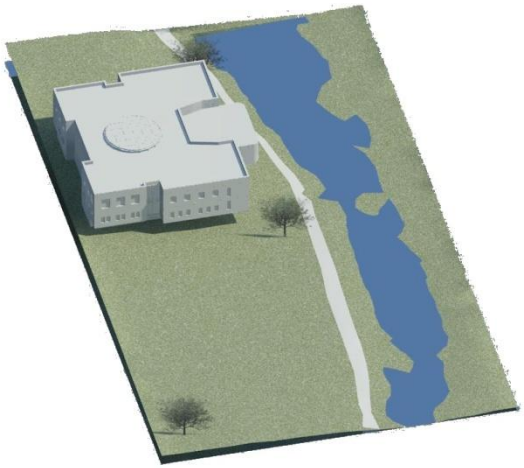


Tornado diagram

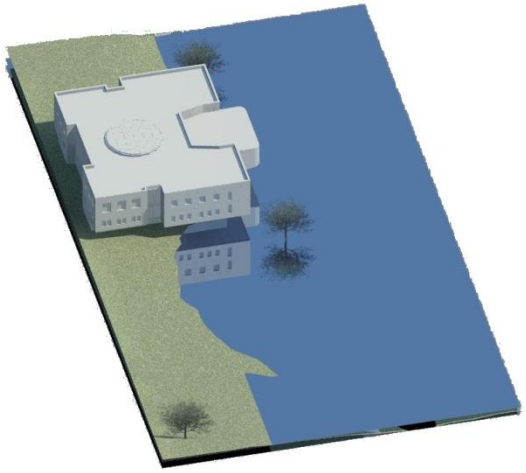


Flooding Challenge

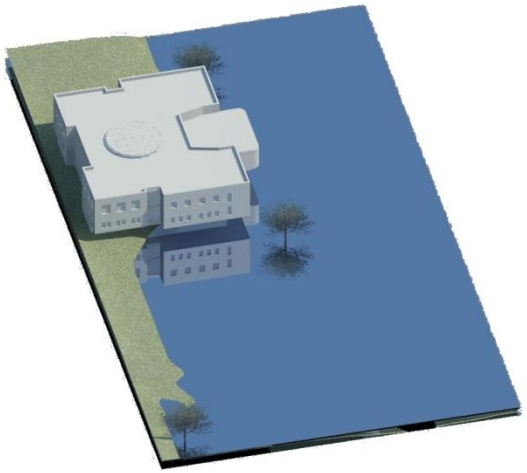
Detailed terrain profile and different water levels



normal water level



33 year flood



100 year flood

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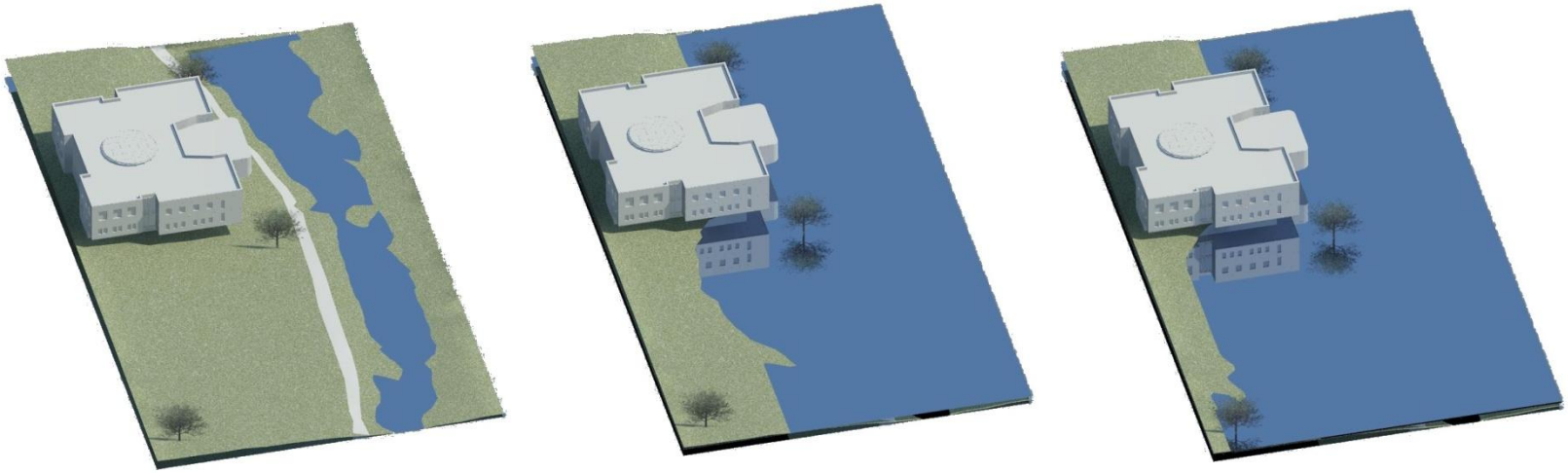

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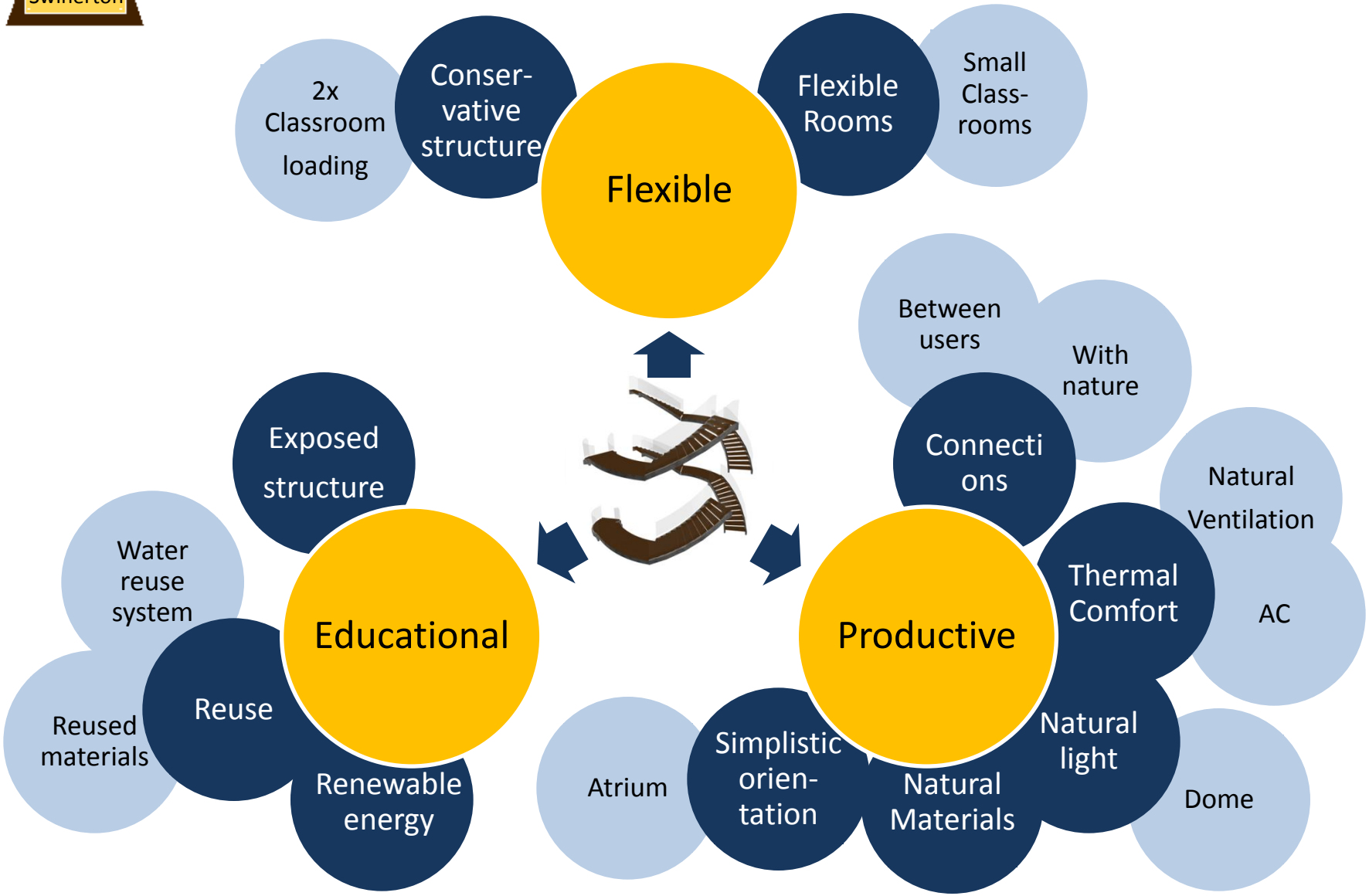
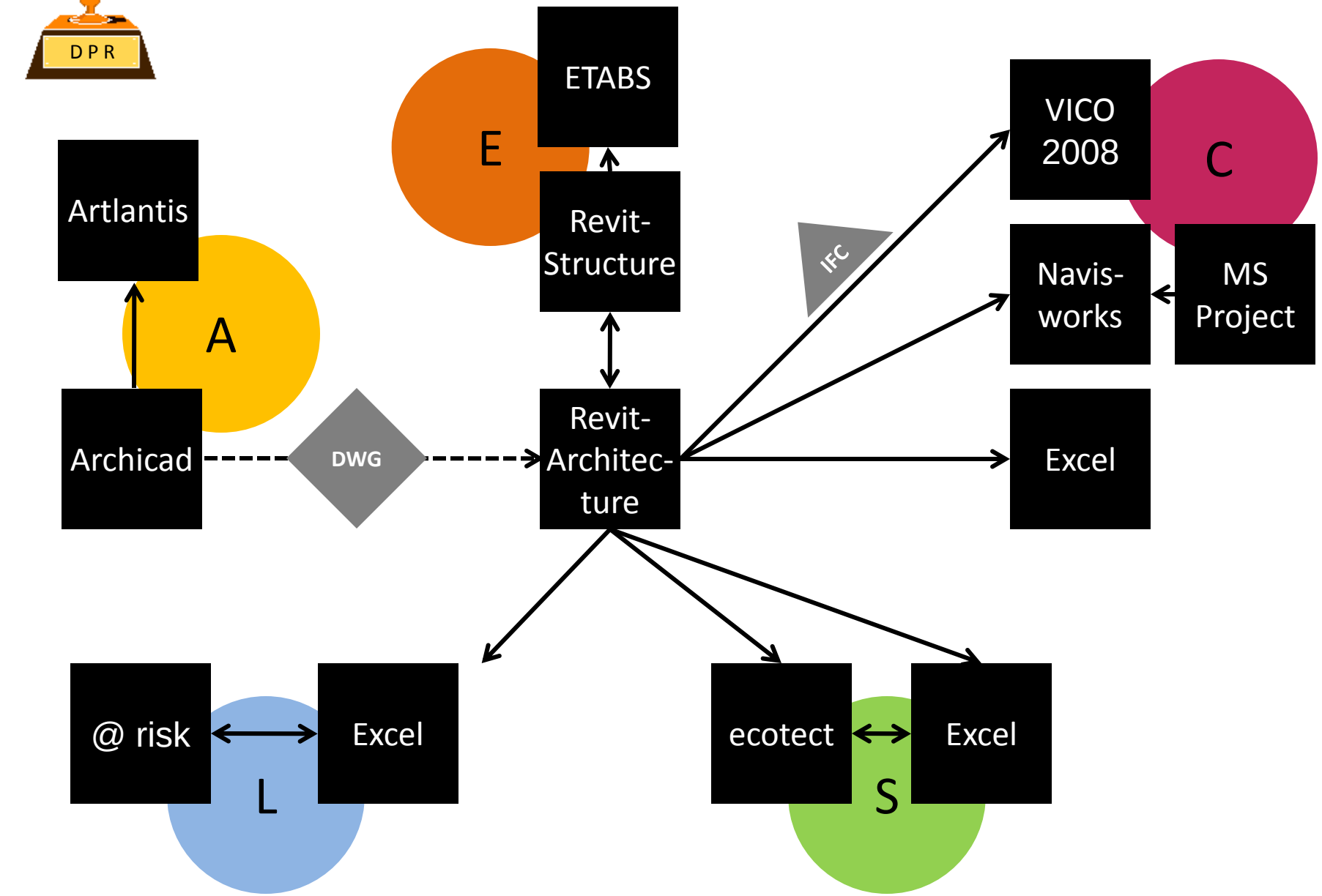
Sustainable Performance

Continuously Enhancing User's Performance



A E C L S

Use of Software



A
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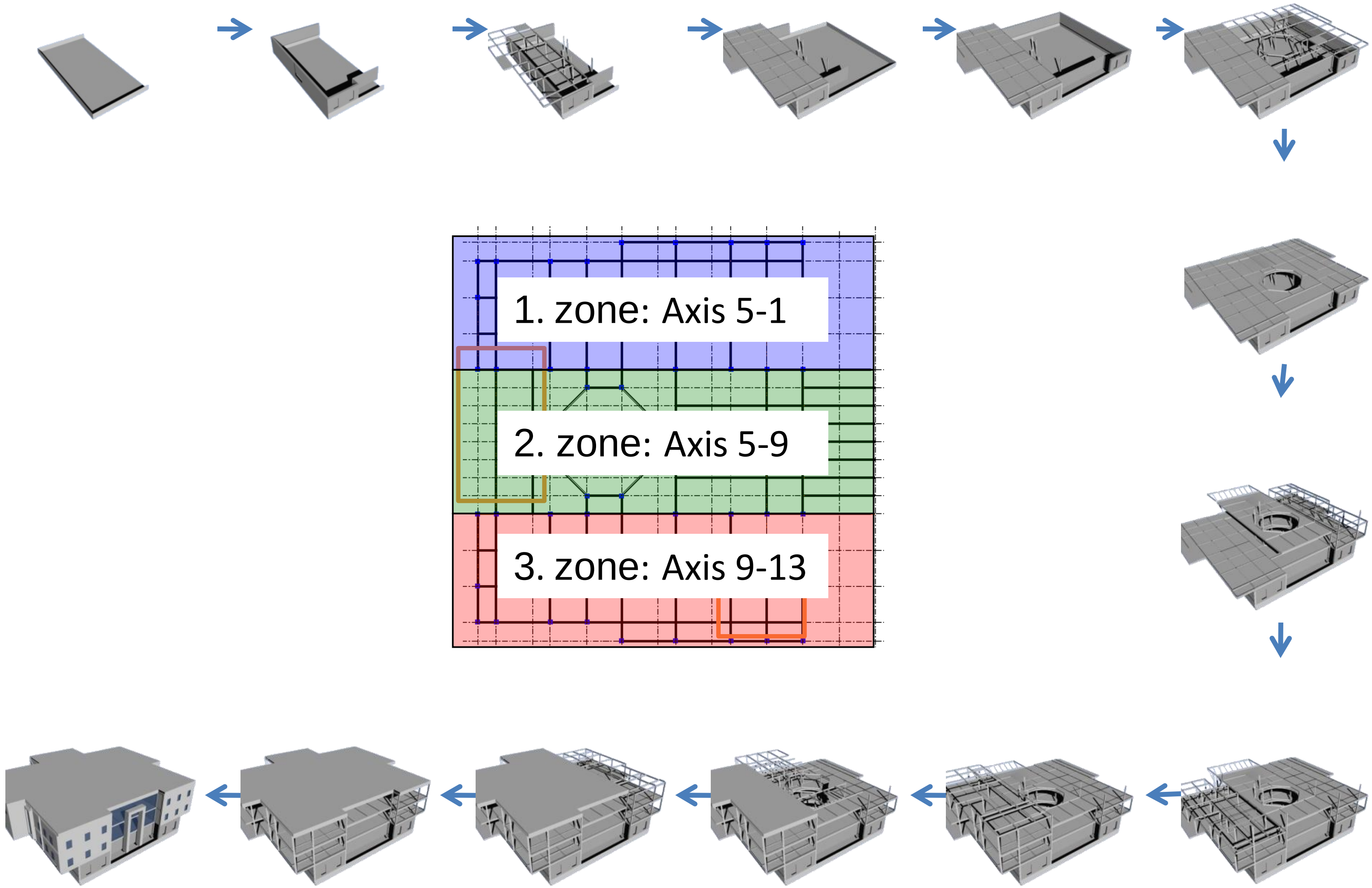
Pre-modeling sequence



A
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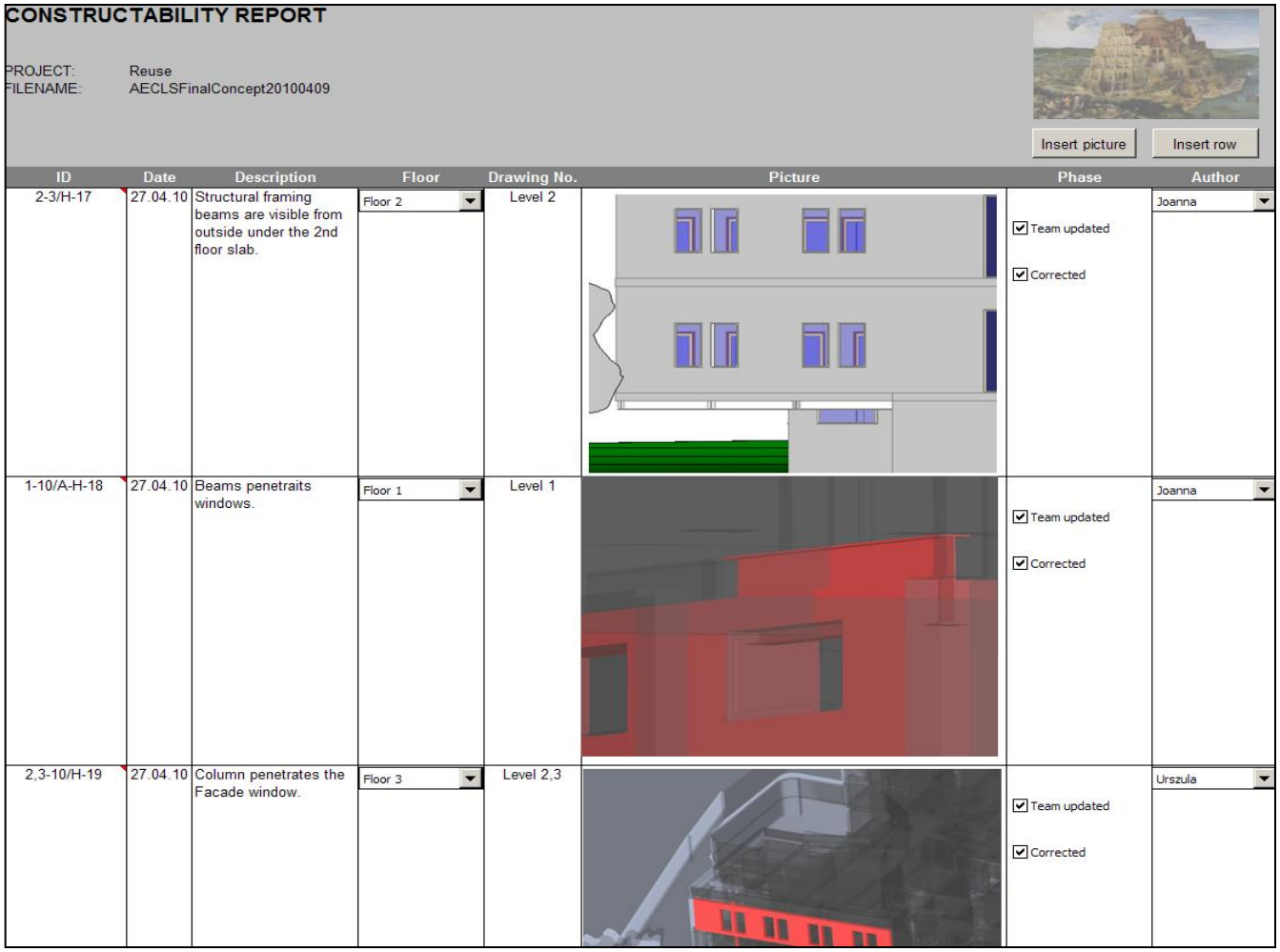
Model Coordination

Autodesk Revit Architecture and Navisworks



CONSTRUCTABILITY REPORT

PROJECT: Reuse
FILENAME: AECLSFinalConcept20100409

Insert picture | Insert row

ID	Date	Description	Floor	Drawing No.	Picture	Phase	Author
2-3/H-17	27.04.10	Structural framing beams are visible from outside under the 2nd floor slab.	Floor 2	Level 2		☑ Team updated ☑ Corrected	Joanna
1-10/A-H-18	27.04.10	Beams penetraits windows.	Floor 1	Level 1		☑ Team updated ☑ Corrected	Joanna
2,3-10/H-19	27.04.10	Column penetrates the Facade window.	Floor 3	Level 2,3		☑ Team updated ☑ Corrected	Urszula

A
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L
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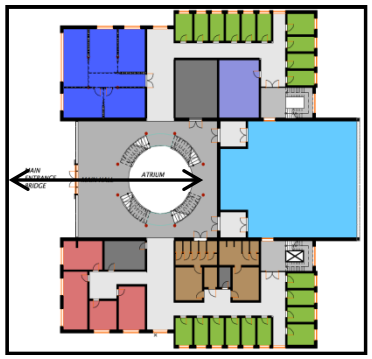
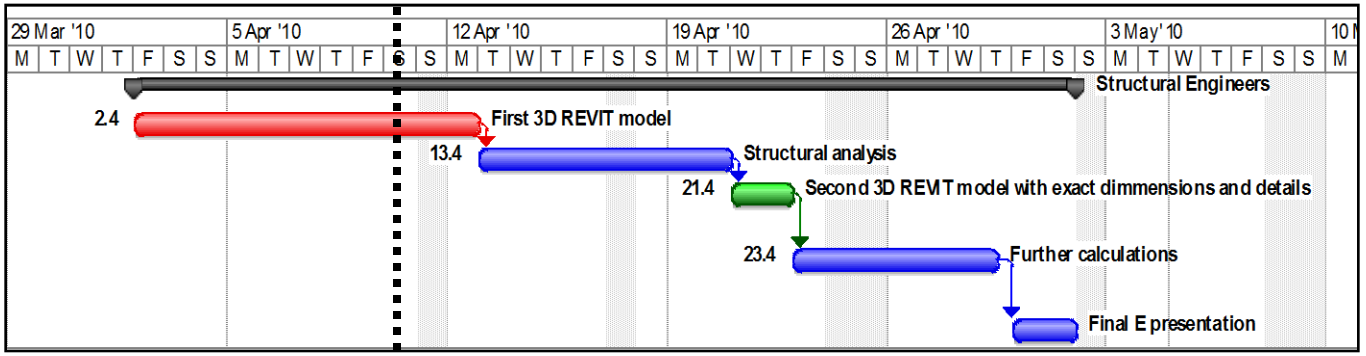
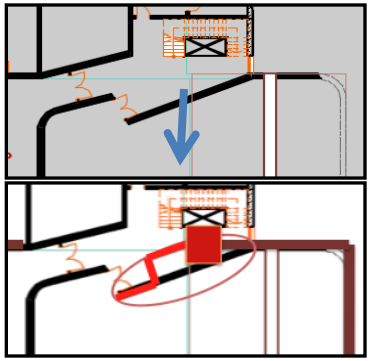
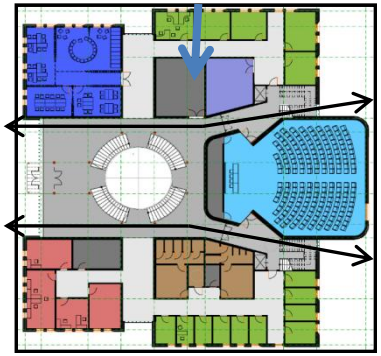
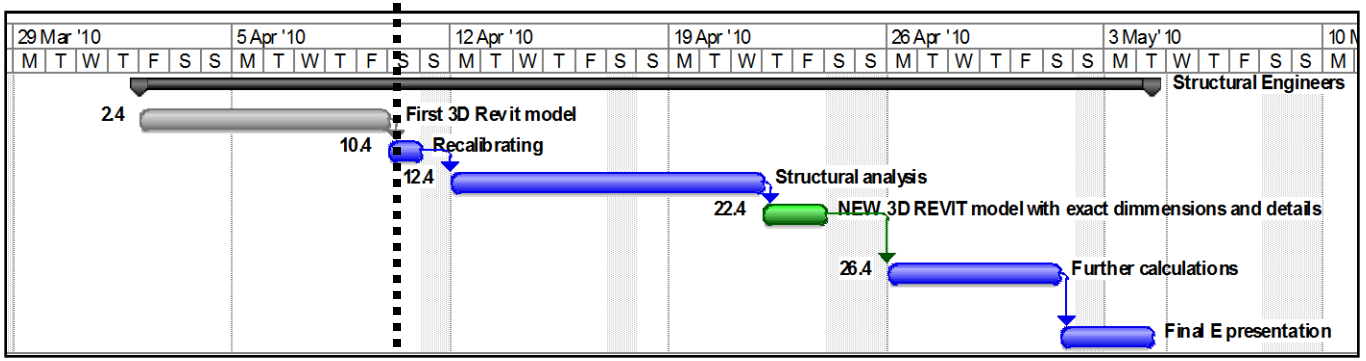
”Little change”











A
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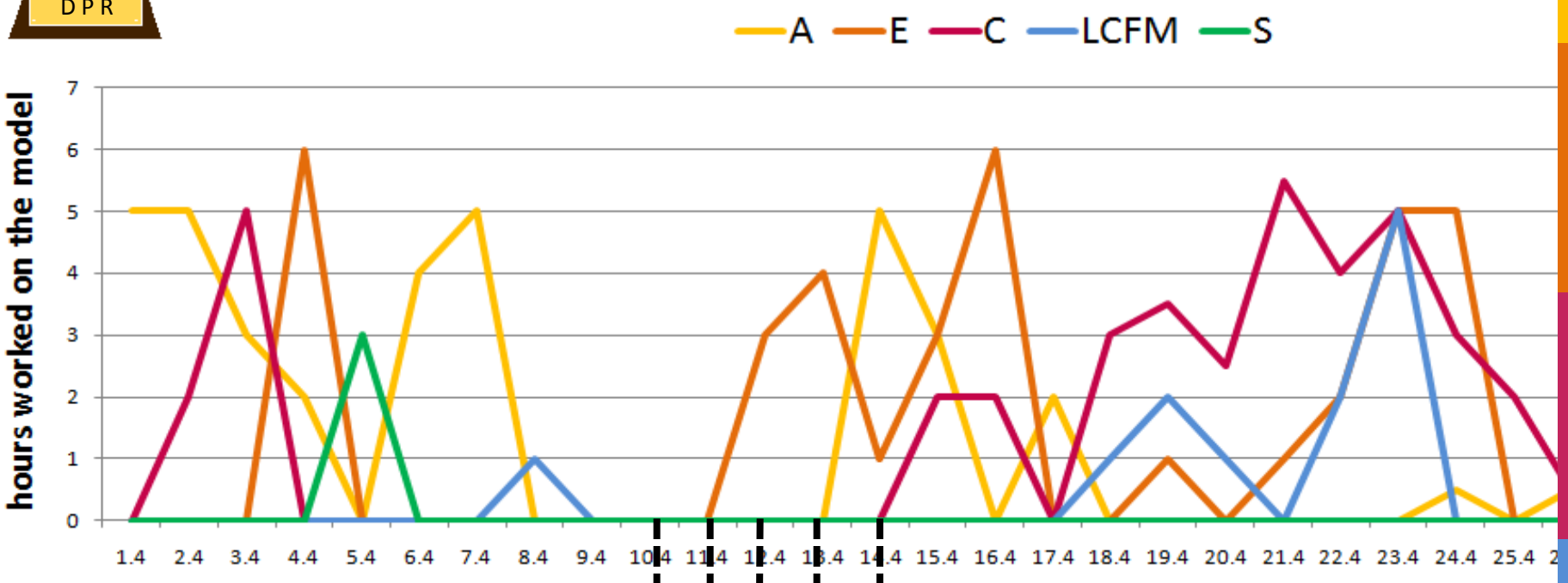
Working on BIM Model



A: "What do you think?"

E: "OK"

E: "Not like this, wait…"

A: "Ok"

C: "OK"

L: "OK"

E: "Change that"

S: "OK"

A

E

C

L

S

Spiral-Stairway to IPD-Success

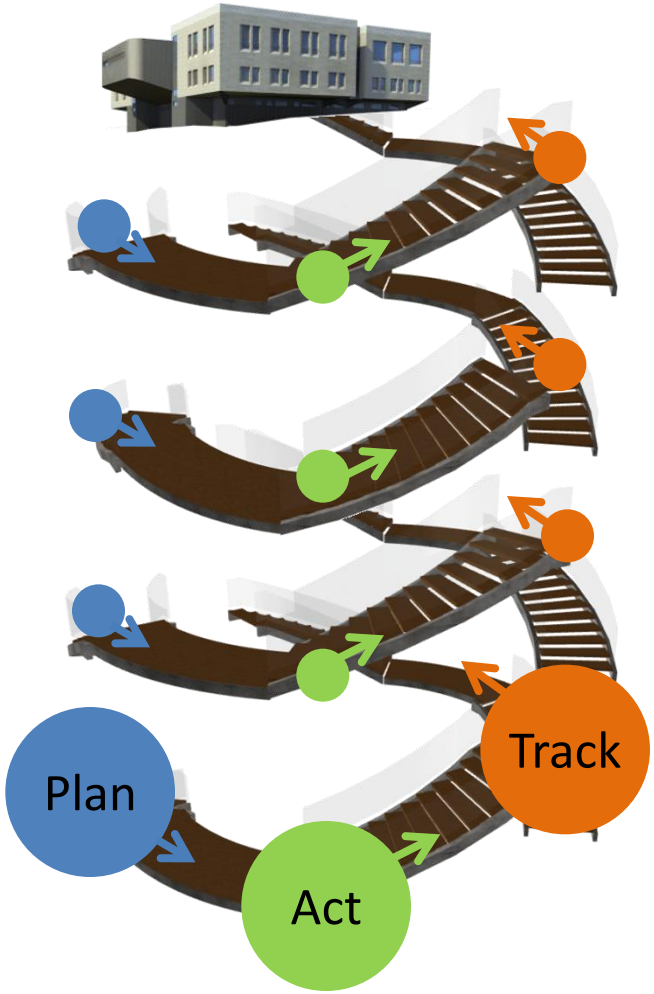
Who needs what from whom, and when?

Early Working Schedule

Pull scheduling

Commitments

1week/1month look ahead



"Go around the table"

Color codes in discipline progression

Weekly recalibrating

Make hidden conversations visible on wave

Tracking BIM-workload

Visible task allocations

Early involvement; Pre-modeling sequence; BIM; Clash detection; Constructability report; Revit flood levels; Early Software testing

A

E

C

L

S

Lessons Learned

“Stay patient”

“What has been committed does not mean it will be completed”

“Collaboration requires exceptional organization in idea and calculation sharing”

“Everything takes much more time than one would expect”

Thank you!

Main Boss:
- Renate Fruchter

Owner:
- Dave Borowicz

Construction Managers:
- Jonas Bill
- Stefan Söderberg
- Terje Håkansson
- Mirko Penko
- Tomo Cerovšek
- Daniel Gonzales

A

Architects:
- Willem Kymmel
- Jan Słyk
- David Bendet

L

Life Cycle Financial Managers:
- Andrea Frank Jungbecker
- Matthias Ehrlich
- Jens-Uwe Wagner
- Tobias Wolff

E

Structure Engineers:
-Professor Oliva
-Greg Luth
-Professor H. Krawinkler
-Professor Bank

S

Sustainable Design Experts:
- Glenn Katz
- Afaan Naqvi