

# U.S. GENERAL SERVICES ADMINISTRATION HEADQUARTERS MODERNIZATION – PHASE 1

1800 F ST. NW, WASHINGTON, D.C.



THE PENNSYLVANIA STATE UNIVERSITY ARCHITECTURAL  
ENGINEERING CAPSTONE PROJECT

RAMUEL HOLGADO | CONSTRUCTION MANAGEMENT OPTION | ADVISOR: DR. CHIMAY ANUMBA





# OVERVIEW

- I. Project Background
- II. Analysis 1: New Addition Façade Redesign
- III. Analysis 2: New Addition Foundation System
- IV. Analysis 3: 3D Laser Scanning Implementation
- V. Analysis 4: Operation and Maintenance of Energy
- VI. Conclusion
- VII. Acknowledgements





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## PROJECT PARTICIPANTS

Owner: **U.S. General Services Administration**

General Contractor: **Whiting-Turner/Walsh Joint Venture**

Construction Manager: **Heery International**

Architects: **Gensler & Shalom Baranes Associates, PC**

Structural Engineer: **Thornton-Tomasetti Group**

MEP Engineer: **Syska**



## BUILDING OVERVIEW – PHASE 1

Location: **1800 F St. NW, Washington, D.C.**

Existing Building Size: **362,000 SF**

New Addition Size: **67,000 SF**

Number of Stories: **9 Stories**

Project Cost: **\$87,069,000**

Dates of Construction: **September 15, 2010 – May 20, 2013**

Project Delivery Method: **Design-Bid-Build**



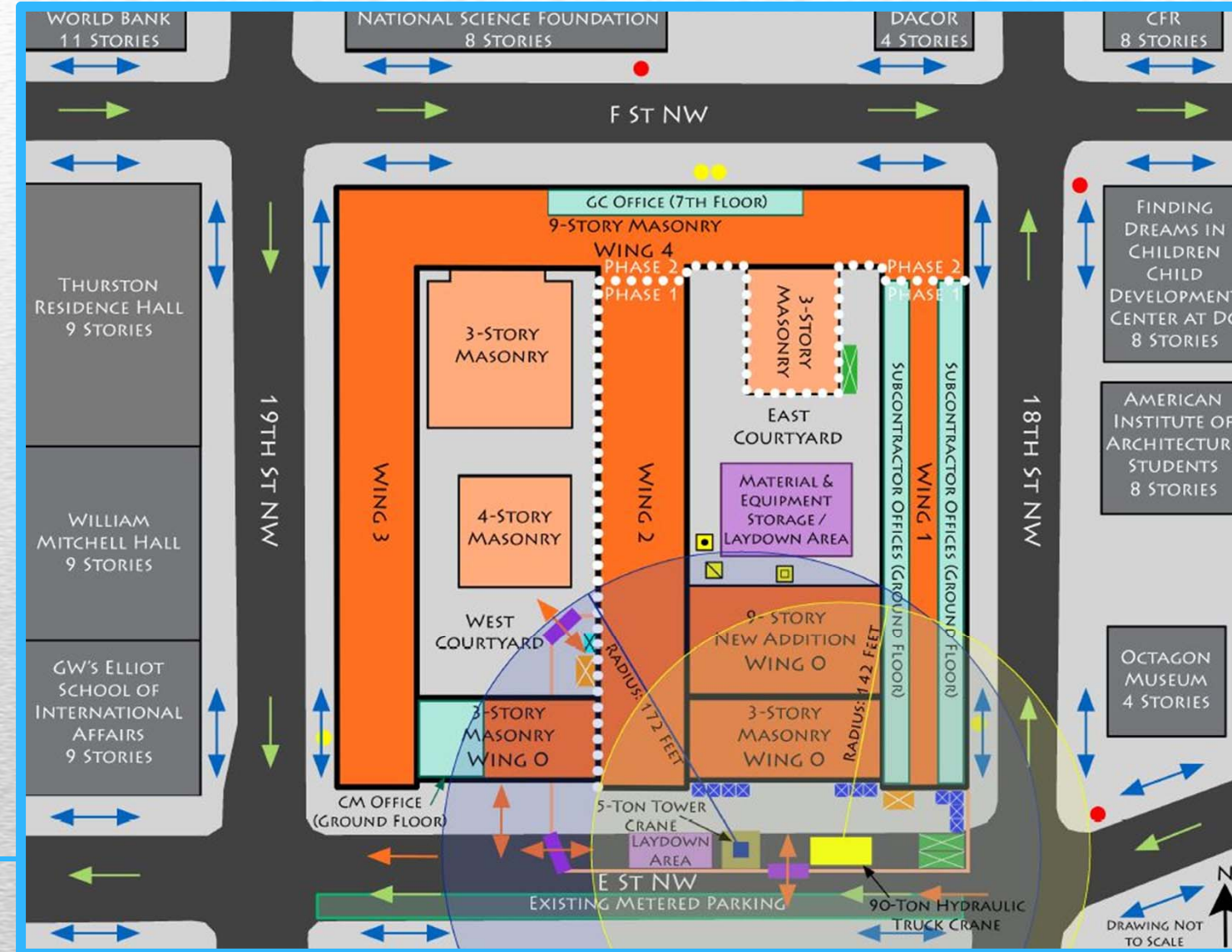
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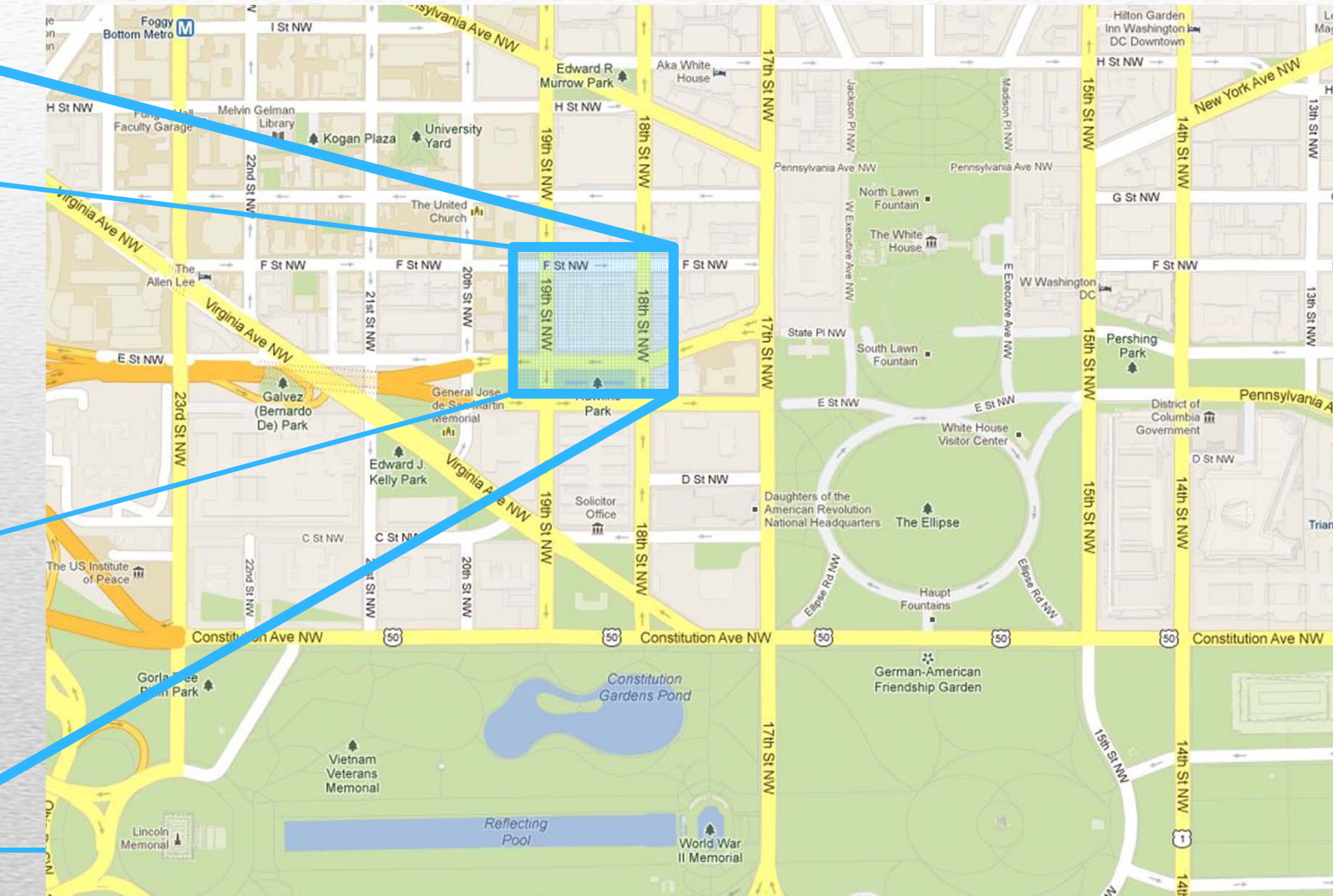


Courtesy of Bing Maps

# CONSTRUCTION SITE PLAN



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Courtesy of Google Maps



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# ANALYSIS 1: NEW ADDITION FAÇADE REDESIGN

## Problem Identification

- Delivery of trusses
- Site congestion
- Cost of smart glass
- Contrasts with neoclassical style

## Proposed Solution

- Downsize the atrium
- Use shorter built-up truss columns

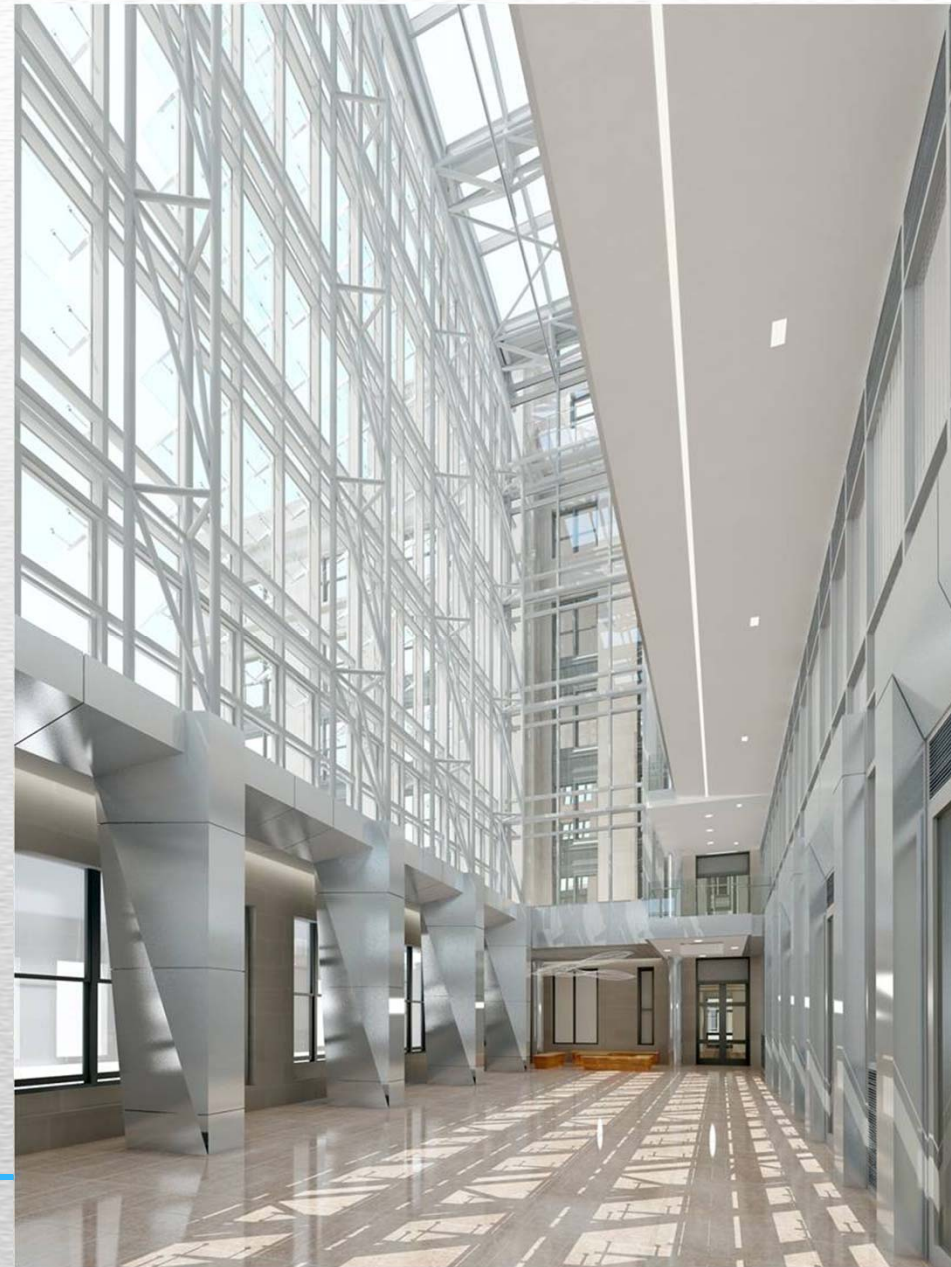
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## ANALYSIS 1: NEW ADDITION FAÇADE REDESIGN

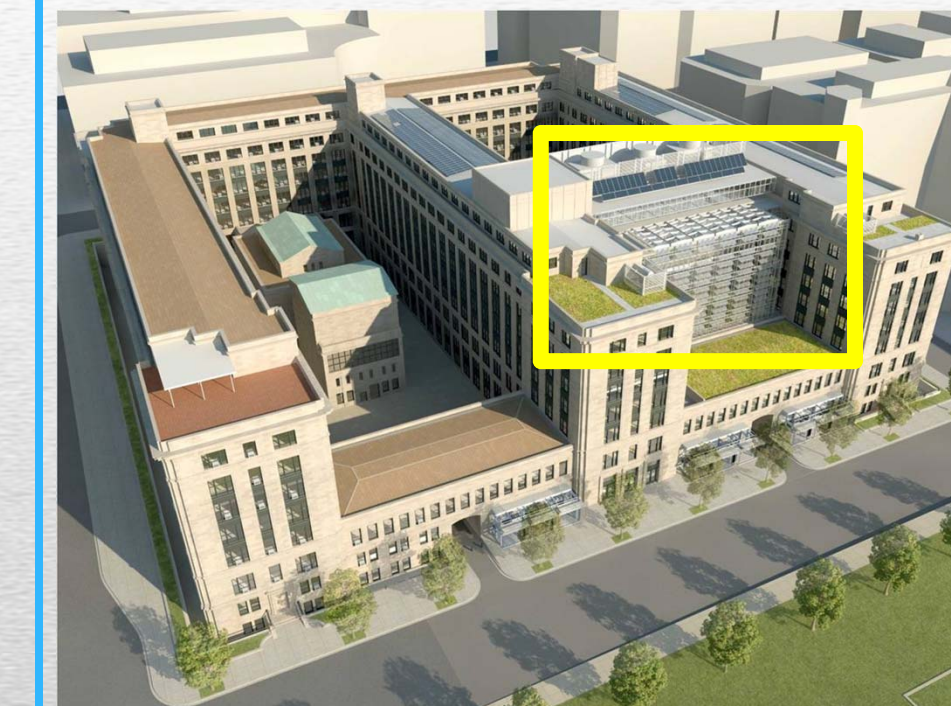
### Original Design

- 78-foot built-up truss columns
- Surface area of glazing: 13,175 SF

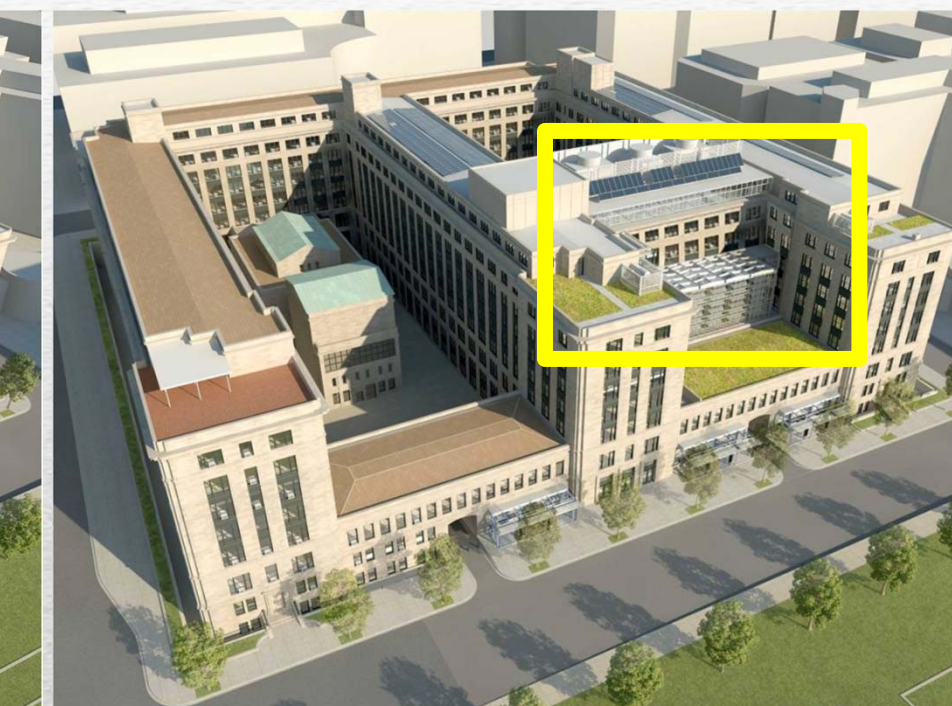
### Alternate Design

- 51-foot built-up truss columns
- Surface area of glazing: 9,000 SF
- Walls of 5<sup>th</sup> and 6<sup>th</sup> floor constructed similar to existing building façade

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1800 F ST., WASHINGTON, D.C.  
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Original Design

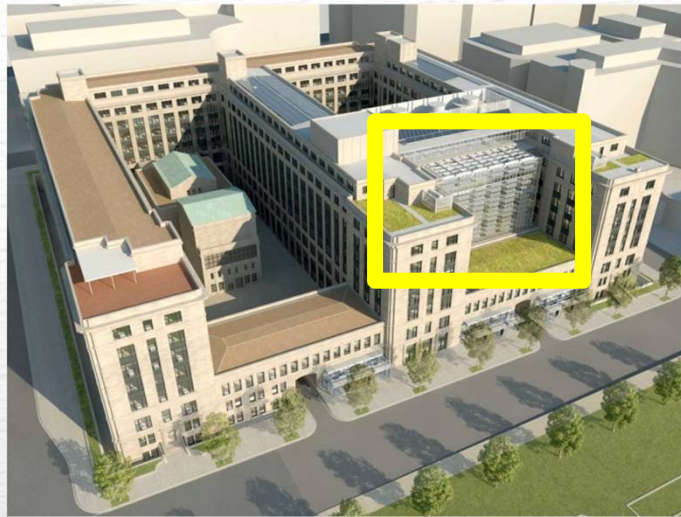


Alternate Design

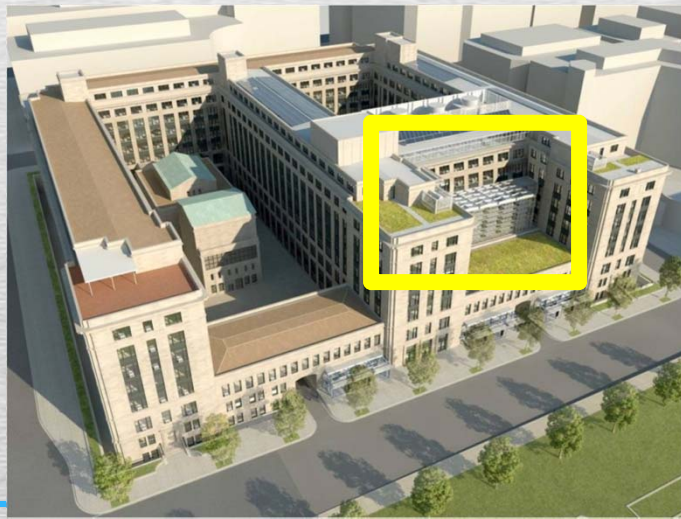


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Original Design



Alternate Design

# ANALYSIS 1: NEW ADDITION FAÇADE REDESIGN

## Cost Comparison

- Original Design TOTAL: \$8,650,000
- Alternate Design TOTAL: \$5,793,914.15
- **SAVINGS: \$2,856,085.85**

Atrium System Cost Comparison						
System	Curtain Wall	Skylights	Atrium Steel	Limestone Wall	Windows	TOTAL
Original	\$5,350,000.00	\$ 800,000.00	\$2,500,000.00	\$ -	\$ -	<b>\$8,650,000.00</b>
Alternate	\$3,017,232.38	\$ 800,000.00	\$1,833,125.66	\$ 106,180.20	\$ 37,375.92	<b>\$5,793,914.15</b>
<b>SAVINGS</b>						<b>\$2,856,085.85</b>

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## Schedule Comparison

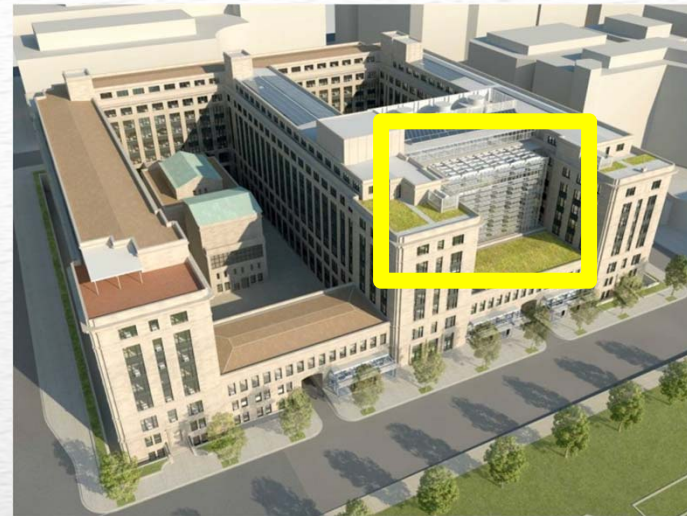
- Original Design TOTAL: 67 days
- Alternate Design TOTAL: 64 days
- **ACCELERATION: 3 days**

Atrium System Schedule Comparison						
System	Curtain Wall	Skylights	Atrium Steel	Limestone Wall	Windows	TOTAL
Original	35	25	7	0	0	<b>67</b>
Alternate	20	25	4	9	6	<b>64</b>
<b>DIFFERENCE</b>						<b>3</b>

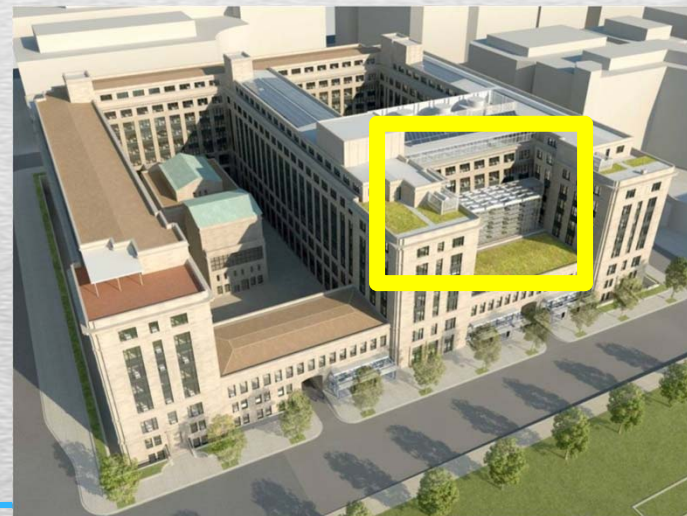


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Original Design



Alternate Design

# ANALYSIS 1: NEW ADDITION FAÇADE REDESIGN

## Conclusion

- Downsizing the New Addition Façade is not recommended
  - Eliminates atrium balcony walkways of the 5<sup>th</sup> and 6<sup>th</sup> floors of the New Addition
    - Restricts pedestrian traffic flow

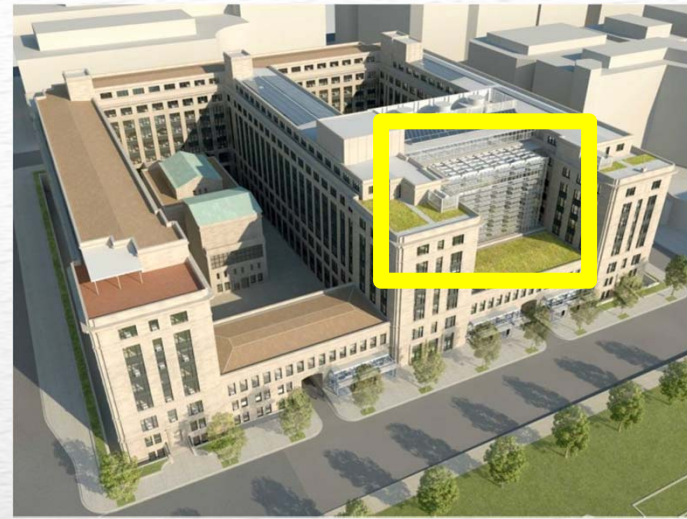
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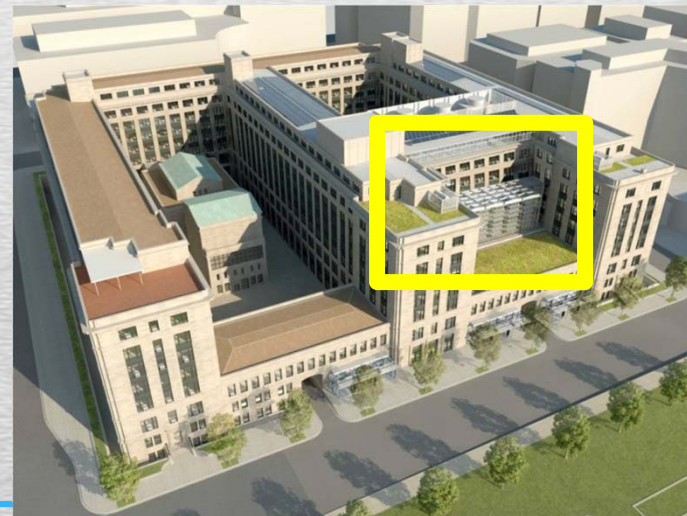


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Original Design



Alternate Design

# ANALYSIS 1: NEW ADDITION FAÇADE REDESIGN

## Acoustical Breadth

- Original Atrium Design (Public Circulation)
  - NC Rating: 46
  - RC Rating: 48
- Alternate Atrium Design (Public Circulation)
  - NC Rating: 46
  - RC Rating: 47
- Alternate 5<sup>th</sup> and 6<sup>th</sup> Floor Design (Open Plan Areas)
  - NC Rating: 40
  - RC Rating: 40

## NC and RC Recommendations

	Type of Area	Recommended NC or RC Criteria Range
1	Private Residences	25 to 30
2	Apartments	25 to 30
3	Hotels/motels	
	a Individual rooms or suites	30 to 35
	b Meeting/banquet rooms	25 to 30
	c Halls, corridors, lobbies	35 to 40
	d Service/support areas	40 to 45
4	Offices	
	a Executive	25 to 30
	b Conference room	25 to 30
	c Private	30 to 35
	d Open plan areas	35 to 40
	e Computer equipment rooms	40 to 45
	f Public circulation	40 to 45



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## ANALYSIS 2: NEW ADDITION FOUNDATION SYSTEM

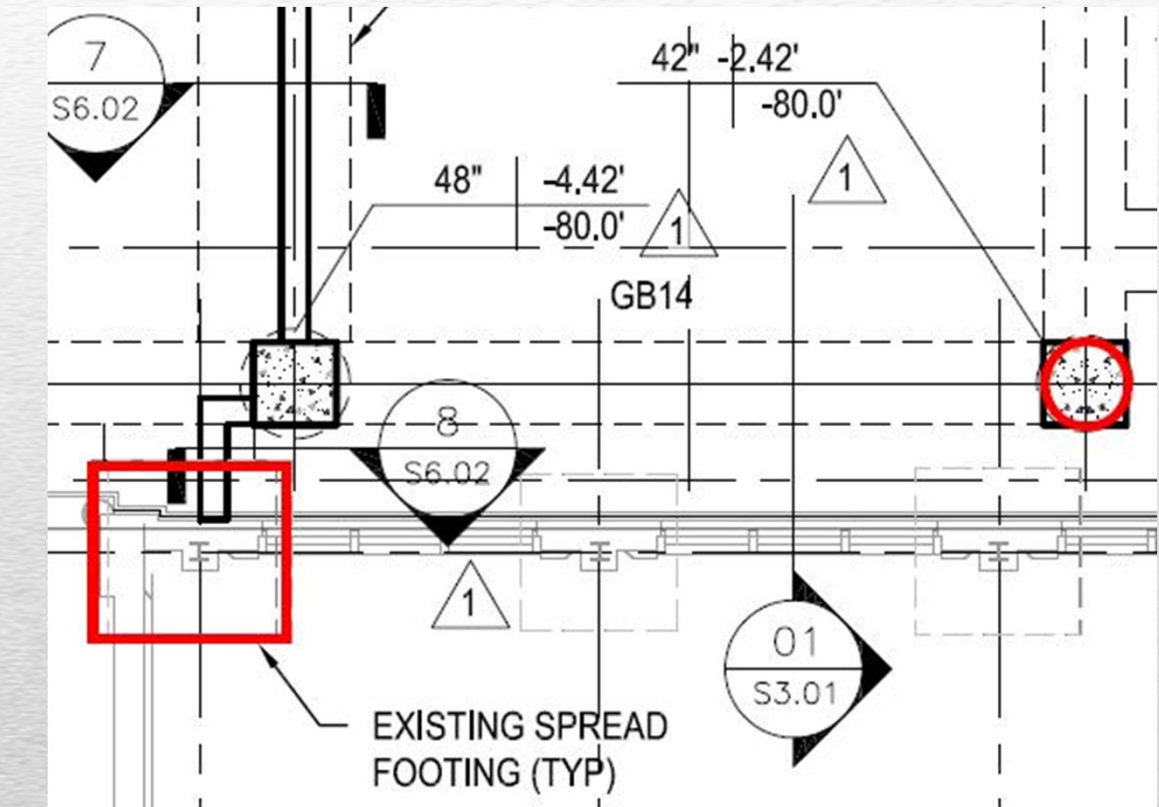
### Problem Identification

- New Addition original foundation system: caissons and grade beams
  - Cost 30% structural system
  - Long duration

### Proposed Solution

- Existing building foundation system: spread footings
- New Addition alternate foundation system: spread footings

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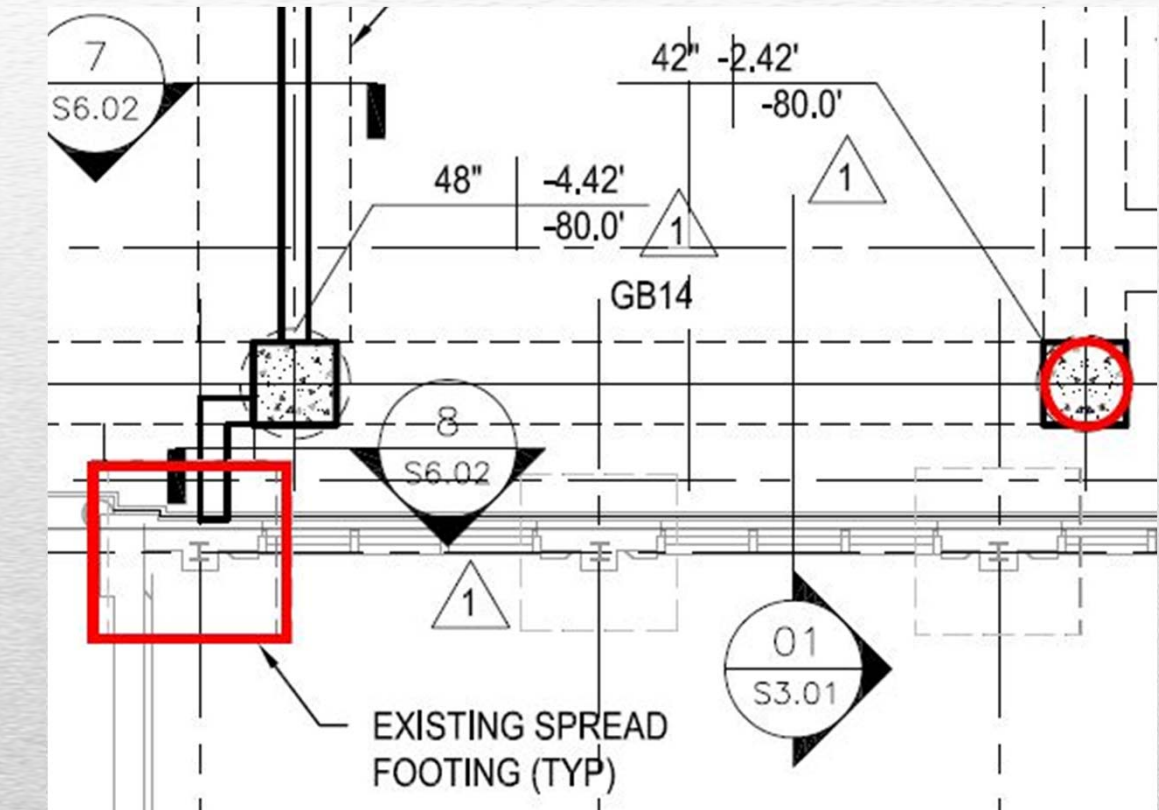
### Geotechnical Report

- Natural soils are relatively consistent with the regional geology and include:
  - Clay
  - Silty clay
  - Clayey-sand
  - Poorly-graded sand
  - Poorly-graded sand and gravel
  - Clayey sand and gravel

### Building Loads and Material Properties

- Column loads = 285k and 225k
- Allowable Soil Bearing Pressure = 5000 psf

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Shaft Diameter (in)	Caisson Schedule Reinforcement		# of Time Used
	Vertical No & Size	Ties Size & Spacing	
30	6 - #7	#4 @ 18"	2
36	8 - #8	#4 @ 18"	1
42	10 - #8	#4 @ 18"	1
48	8 - #10	#5 @ 18"	2
54	10 - #10	#5 @ 18"	3
66	12 - #11	#5 @ 18"	4
72	14 - #11	#5 @ 18"	4
78	16 - #11	#5 @ 18"	2
84	18 - #11	#5 @ 18"	1
90	22 - #11	#5 @ 18"	1
96	24 - #11	#5 @ 18"	3
102	28 - #11	#5 @ 18"	1

# ANALYSIS 2: NEW ADDITION FOUNDATION SYSTEM

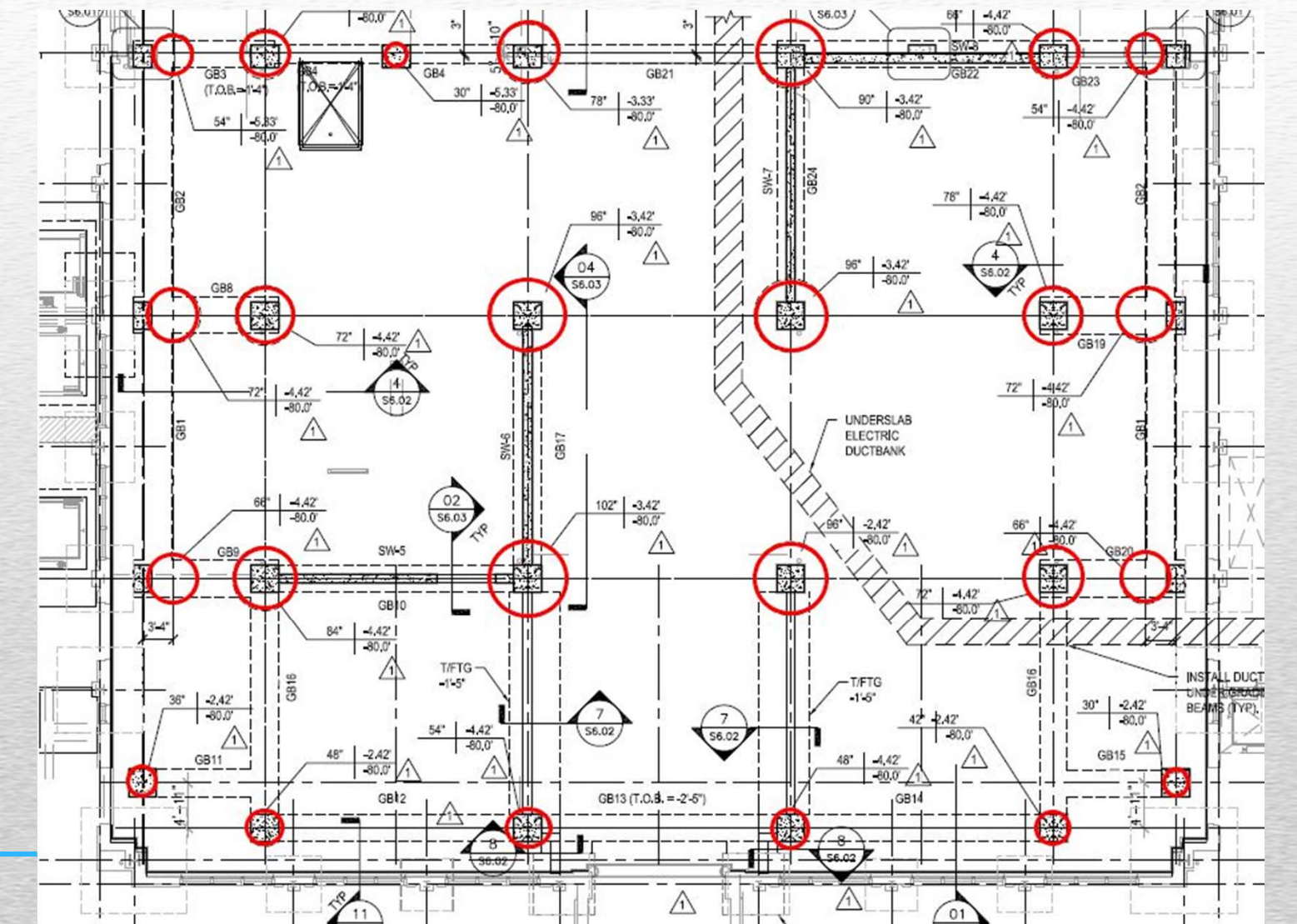
## Existing Building Foundation System

- Typical spread footing:
  - Size: 7'-4" x 7'-4" x 2'-6"

## New Addition Original Foundation System

- 25 caissons
  - Shaft diameters: 30 inches to 102 inches
  - Drilled 75 feet to 80 feet deep
- 24 grade beams

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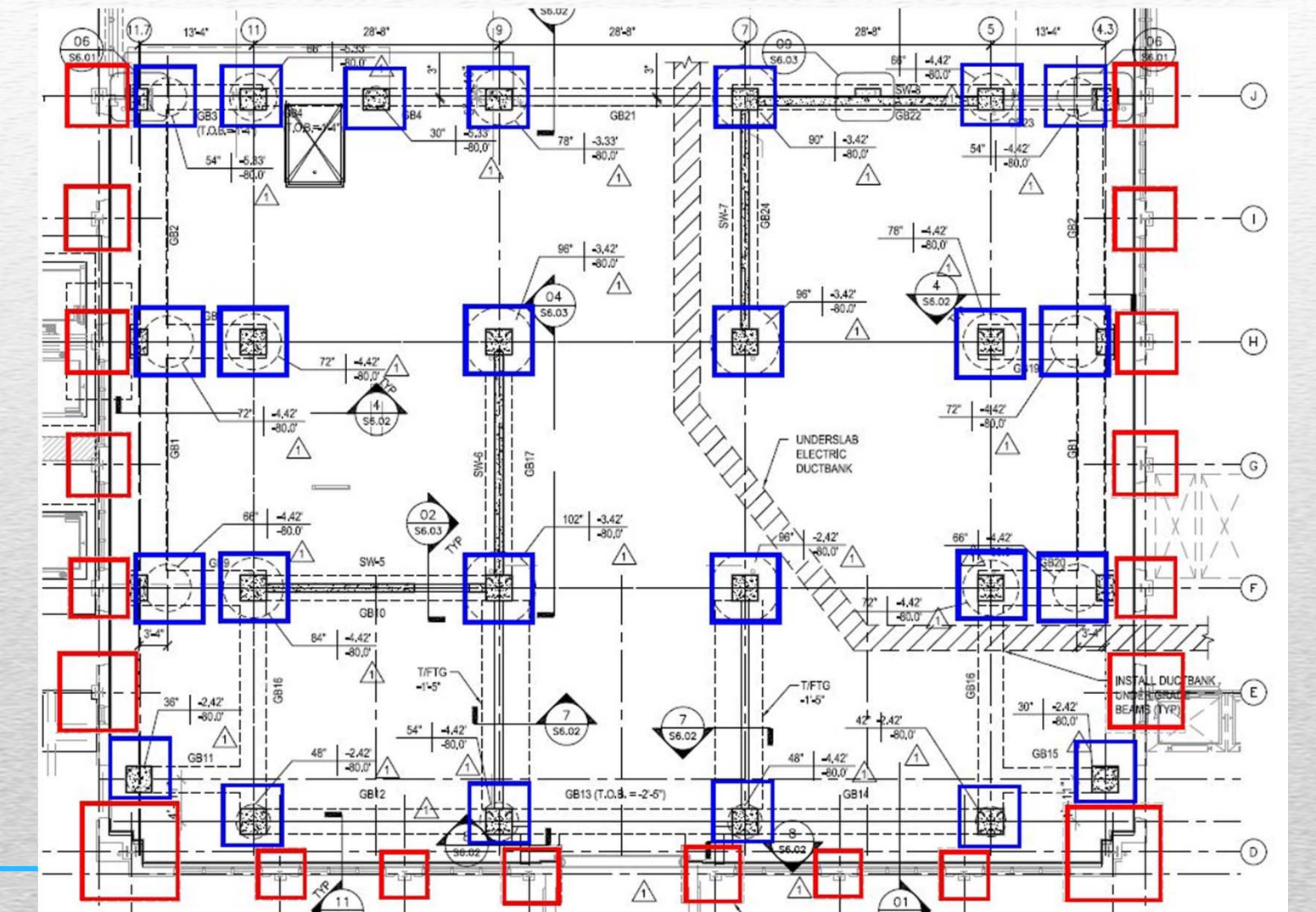
Location	Concrete			Reinforcement						
	W (ft)	L (ft)	H (ft)	Cubic Feet	Cubic Yards	Formwork (SFCA)	Bottom Bars	Top Bars	Weight (lbs)	Weight (tons)
D-4.3	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
D-5	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
D-7	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
D-9	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
D-11	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
D-11.7	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
F-4.3	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
F-5	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	233.63	0.12
F-7	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
F-9	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
F-11	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
F-11.7	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
H-4.3	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
H-5	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
H-7	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
H-9	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
H-11	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
H-11.7	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
J-4.3	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
J-5	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
J-7	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
J-9	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
J-10	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
J-11	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
J-11.7	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
<b>TOTAL</b>				<b>61.52</b>	<b>876.00</b>	<b>3.35</b>				
<b>TOTAL + WASTE FACTOR</b>				<b>64.59</b>	<b>919.80</b>	<b>3.52</b>				

# ANALYSIS 2: NEW ADDITION FOUNDATION SYSTEM

## New Addition Alternate Foundation System

- 25 total spread footings
  - 12 interior spread footings (P = 285k)
    - Size: 8' x 8' x 1'-4"
  - 13 exterior spread footings (P = 225k)
    - Size: 7' x 7' x 1'

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 1800 F ST., WASHINGTON, D.C.  
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## ANALYSIS 2: NEW ADDITION FOUNDATION SYSTEM

### Cost Comparison

- Original Foundation System TOTAL: \$1,755,000
- Alternate Foundation System TOTAL: \$203,857.78
- **SAVINGS: \$1,551,142.22**

Foundation System Cost Comparison				
System	Caissons	Grade Beams	Spread Footings	TOTAL
Original	\$ 1,560,000.00	\$ 195,000.00	\$ -	\$ 1,755,000.00
Alternate	\$ -	\$ -	\$ 203,857.78	\$ 203,857.78
<b>SAVINGS</b>				<b>\$ 1,551,142.22</b>

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### Schedule Comparison

- Original Foundation System TOTAL: 47 days
- Alternate Foundation System TOTAL: 12 days
- **ACCELERATION: 35 days**

Foundation System Schedule Comparison				
System	Caissons	Grade Beams	Spread Footings	TOTAL
Original	27	20	0	47
Alternate	0	0	12	12
<b>DIFFERENCE</b>				<b>35</b>





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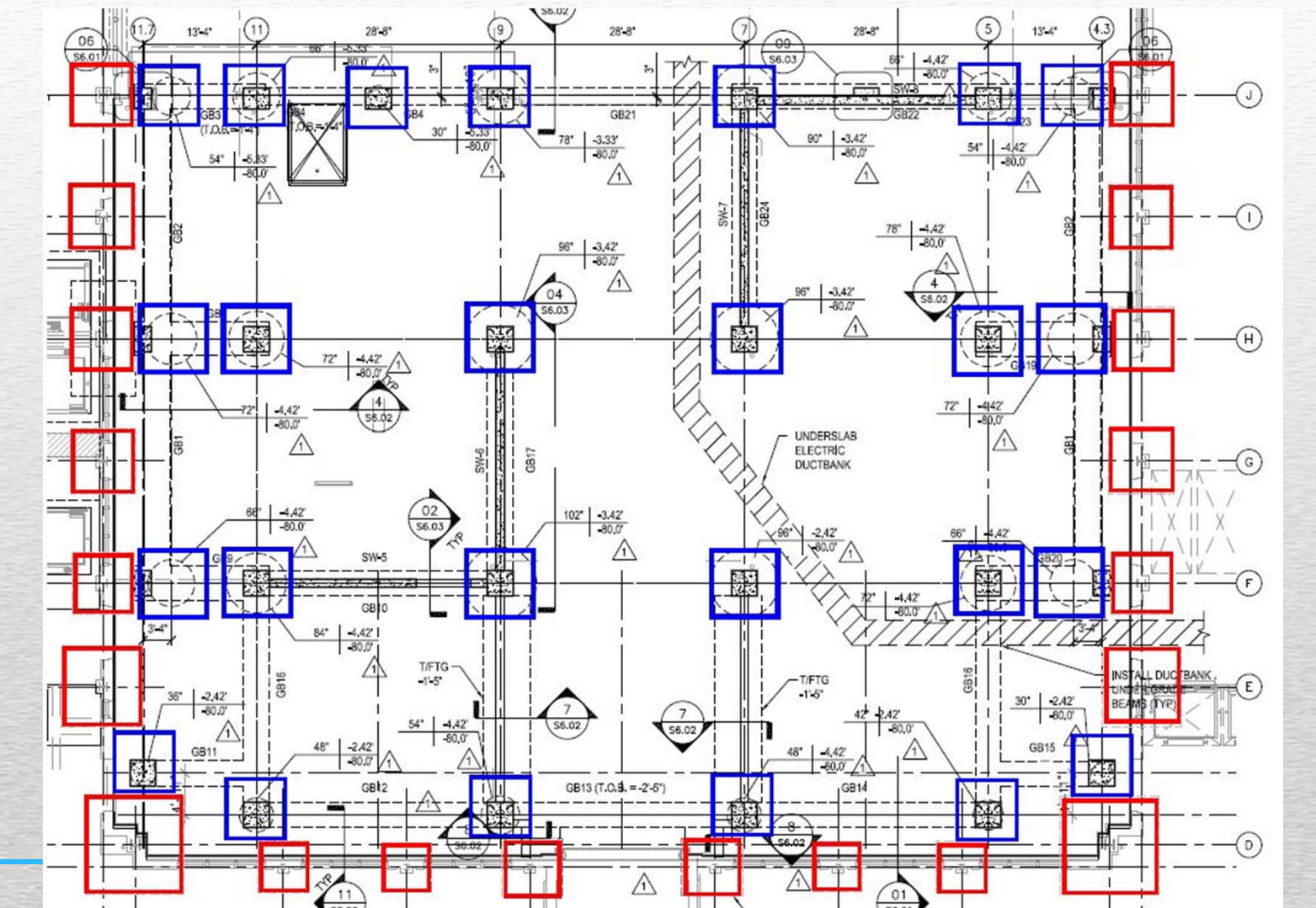
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## ANALYSIS 2: NEW ADDITION FOUNDATION SYSTEM

### Conclusion

- Spread footings as the foundation system for the New Addition is not recommended
  - Space constraints of East Courtyard
  - Designed spread footings located up against existing spread footings

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1800 F ST., WASHINGTON, D.C.  
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## ANALYSIS 3: 3D LASER SCANNING IMPLEMENTATION

### Problem Identification

- Outdated as-built drawings
- Project did not utilize BIM

### Proposed Solution

- Leica ScanStation C10
- Leica Cyclone

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### ScanStation C10

- 3D laser scanner
- Full-dome interior scans in minutes

### Cyclone

- 3D point cloud processing software
- Web-based sharing and viewing



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## ANALYSIS 3: 3D LASER SCANNING IMPLEMENTATION

### Creation of As-Built Drawings

- 2D as-built drawings
  - Plans, elevations, sections, and details
- 3D models of existing conditions

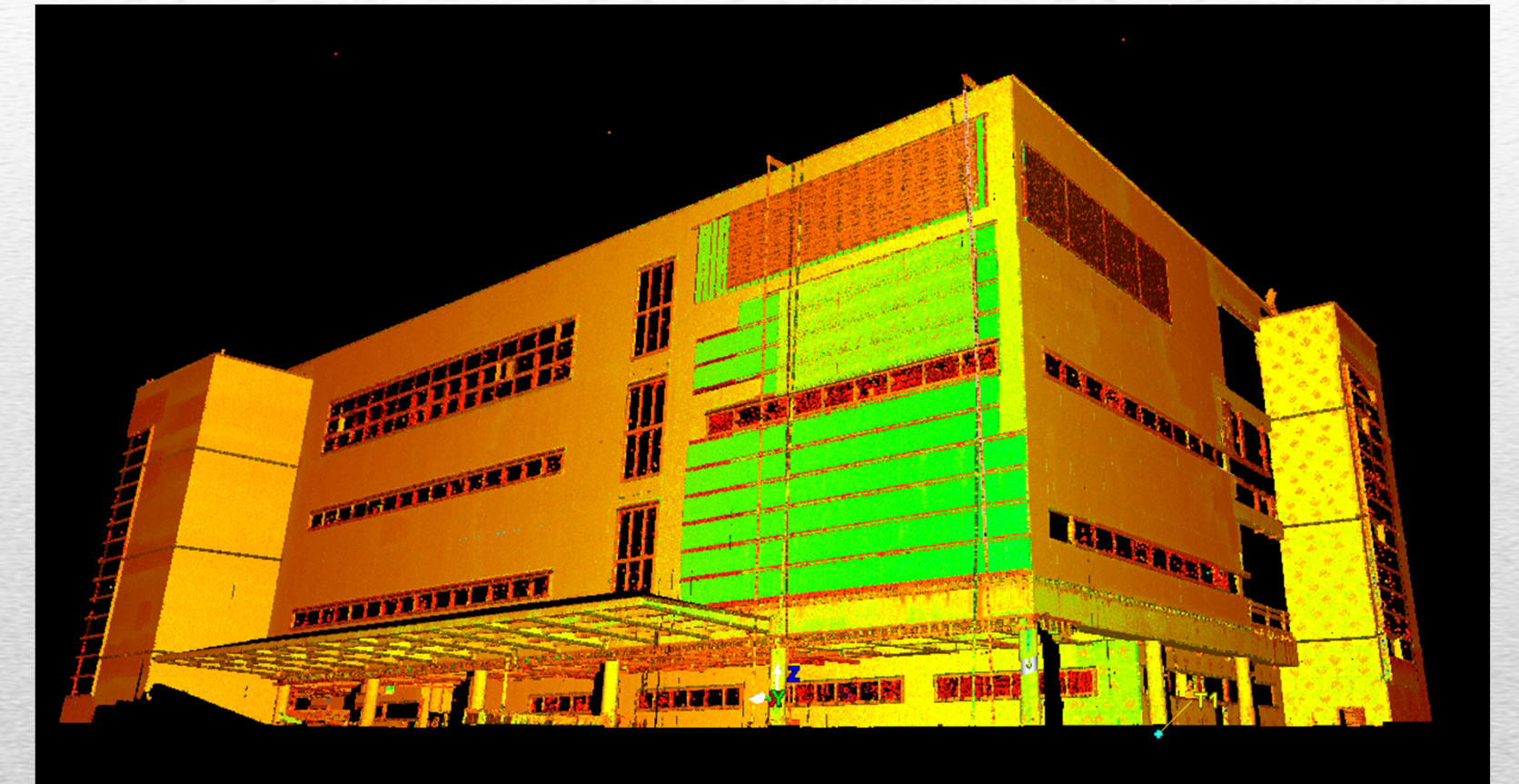
### Improved Coordination and Design

- Simultaneous access of 3D point cloud data sets and models from anywhere
- Clash detection

### Quality Control Verification On Site

- Slab levelness, truss column plumbness, installation locations, etc.
- Quality control will be maintained throughout the project

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## ANALYSIS 3: 3D LASER SCANNING IMPLEMENTATION

U.S. GENERAL SERVICES ADMINISTRATION HEADQUARTERS MODERNIZATION – PHASE 1  
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### Cost of Implementation

- Initial cost of equipment: \$150,000
- Cost of maintenance: \$52,000
- Cost of labor for scanning and processing: \$15,200
- **TOTAL: \$217,200**

### Cost of Change Orders

- **Estimated Cost: Up to \$424,892**
- Change orders potential impacted:
  - New Addition Curtain Wall
  - Wing 2 Trench Infill
  - Sixth Floor Wing 2 Rebuild Columns
  - Additional Ceiling Height Change on Third and Fourth Floors of Wing 2
  - Additional Concrete Demolition at the East Courtyard
  - Window Sill Repairs

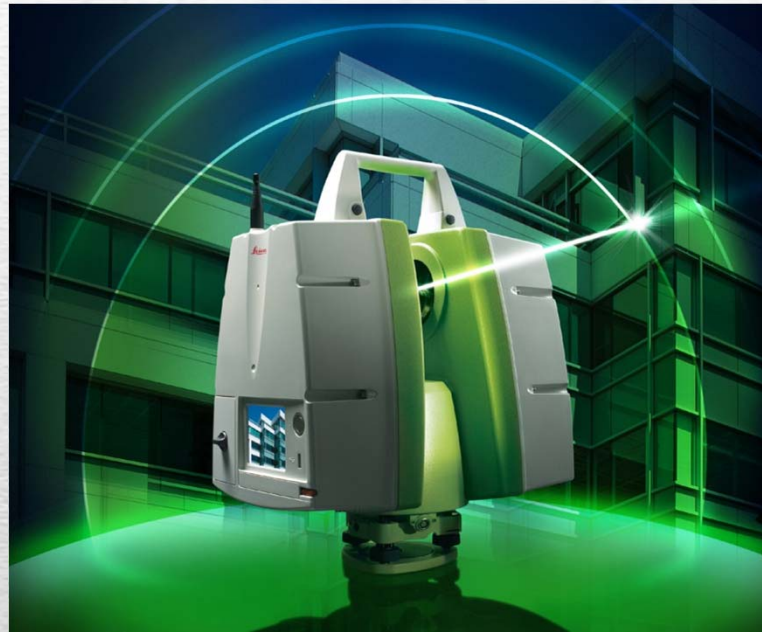
### Schedule Summary

- Scan 9 total floors at approximately 48,000 SF each: 9 days
- Process the data to create a model: 10 days
- **TOTAL: 19 days**



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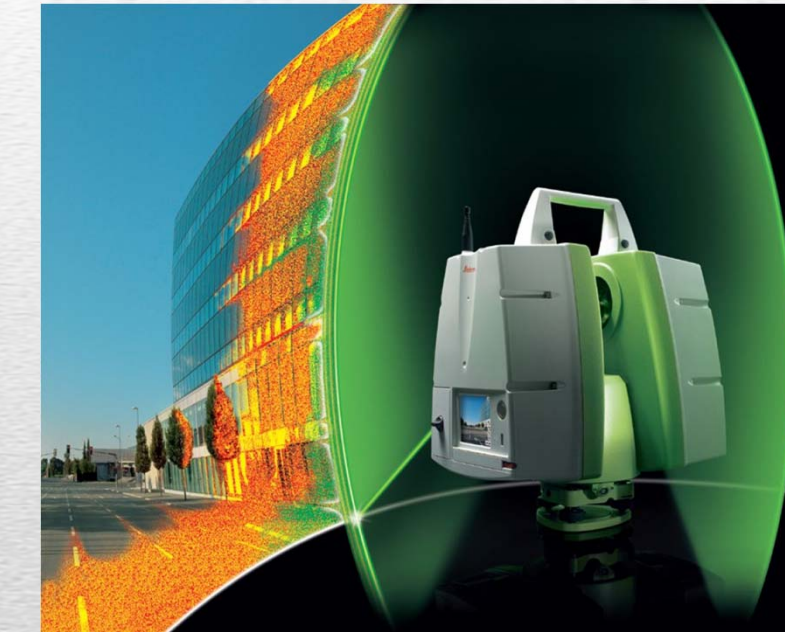


# ANALYSIS 3: 3D LASER SCANNING IMPLEMENTATION

## Conclusion

- 3D Laser Scanning is recommended
  - GSA should purchase and maintain equipment instead of renting the process

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RAMUEL HOLGADO | CONSTRUCTION MANAGEMENT OPTION





# OVERVIEW

- I. Project Background
- II. Analysis 1: New Addition Façade Redesign
- III. Analysis 2: New Addition Foundation System
- IV. Analysis 3: 3D Laser Scanning Implementation
- V. Analysis 4: Operation and Maintenance of Energy**
- VI. Conclusion
- VII. Acknowledgements



## ANALYSIS 4: OPERATION AND MAINTENANCE OF ENERGY

### Problem Identification

- Buildings becoming more complex to operate
- Occupants have no way of getting feedback on their energy usage

### Proposed Solution

- Building Dashboard by Lucid Design Group
  - Operational phase

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“Building Dashboard has been designed to be the most technically capable and visually spectacular data monitoring and display system available for commercial and institutional facilities.”  
-Lucid Design Group





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# ANALYSIS 4: OPERATION AND MAINTENANCE OF ENERGY

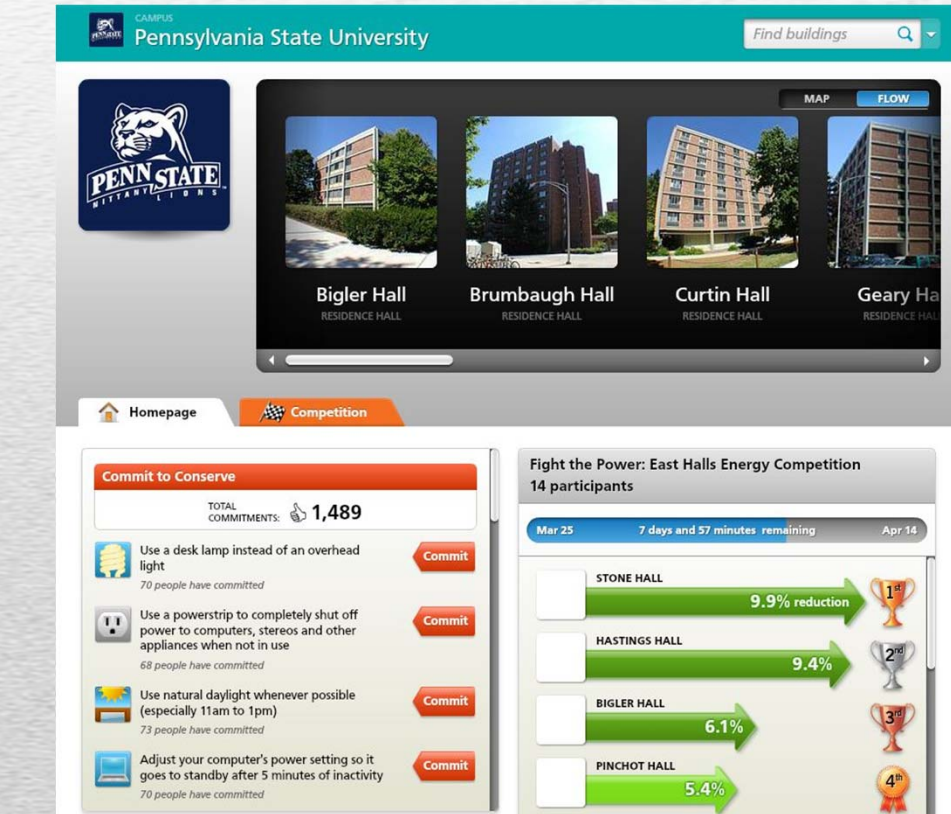
## Building Dashboard

- Connects to virtually all building automation and energy management systems
- Connects to all utility meters and submeters
- Monitors all resources consumed within a building including:
  - Electricity
  - Water
  - Natural gas
  - Heating
  - Cooling
  - Solar electricity
  - Wind electricity
  - Solar thermal energy
  - Geothermal energy
  - Rainwater collection and recycling
  - Wastewater recycling

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## Building Dashboard Network

- A social network for building occupants
- Implemented on East Halls at the Pennsylvania State University





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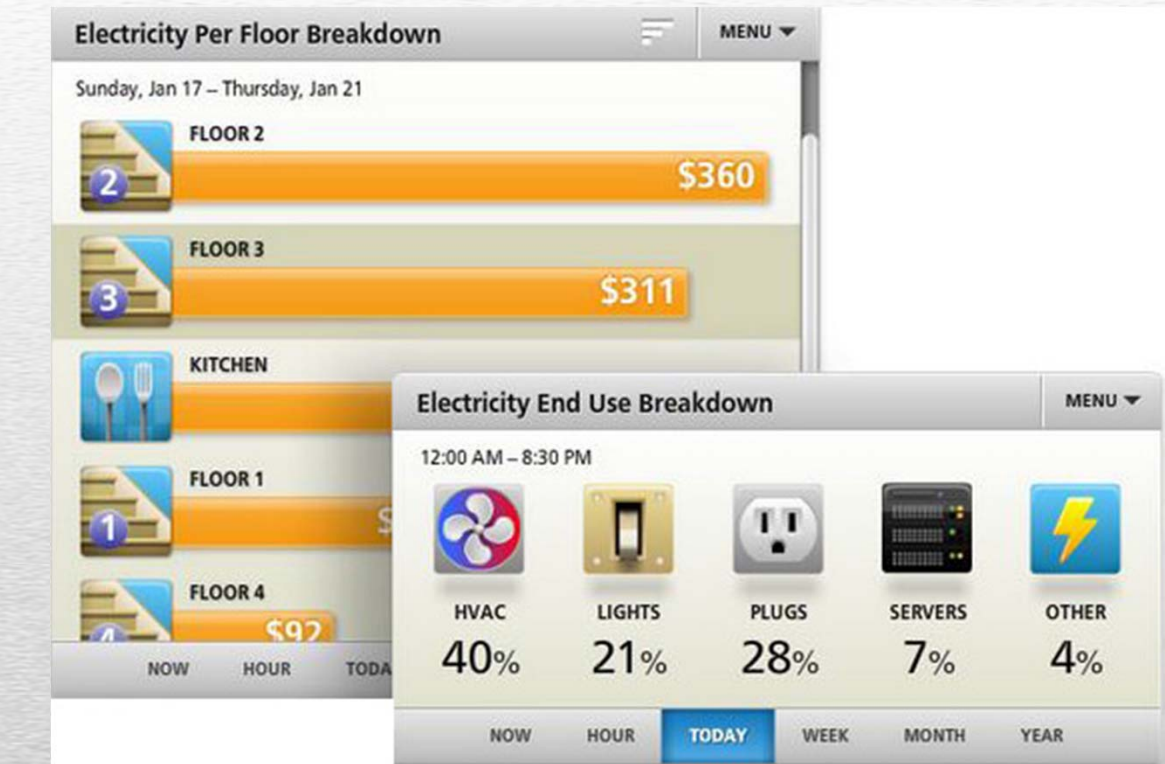
## Track and Monitor Resource Consumption

- Fully automated data collection, processing, and storage
- Resource consumption
  - Breakdown by wing, floor, room, and end use

## Real-Time Competitions

- Competitions may be held between individual floors, buildings, and entire organizations
- Studies have shown that competitions can facilitate reductions as high as 56%

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U.S. Climate Zone 3		
Building Type	Annual Energy Use (kBtu/sq.ft.)	Annual Energy Cost (\$/sq.ft.)
Education	69	\$0.99
Food service	213	\$2.73
Health care (inpatient)	204	\$2.35
Health care (outpatient)	80	\$1.30
Lodging	96	\$1.86
Office	80	\$1.59
Public assembly	66	\$1.19
Religious worship	35	\$0.45
Restaurant	226	\$4.16
Retail	64	\$1.25
Warehouse (non-refrig.)	51	\$0.93
Warehouse (refrigerated)	65	\$1.47



## ANALYSIS 4: OPERATION AND MAINTENANCE OF ENERGY

### Energy Consumption

- Annual Energy Rate: \$1.59/SF
- Phase 1 SF: 429,000 SF
- **Annual Energy Cost: \$682,110**

### Potential Savings

- 30.4% reduction (Google NYC Office)
- Estimated Annual Energy Cost: \$474,748.56
- **Estimated Annual Savings: \$207,361.44**

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### Cost of Implementation

- Lucid Design Group was unable to provide a quote for the implementation of Building Dashboard onto the GSA Headquarters



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## ANALYSIS 4: OPERATION AND MAINTENANCE OF ENERGY

### Conclusion

- Implementation of Building Dashboard is not recommended at this time
  - Relies solely on occupant behavior
  - Only as good as the engagement programs that integrate it
  - More long-term studies need to be conducted
  - Cost of implementation is unknown at this time

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# CONCLUSIONS

## Analysis 1: New Addition Façade Redesign

- Downsizing the New Addition Façade is not recommended
  - Eliminates atrium balcony walkways of the 5<sup>th</sup> and 6<sup>th</sup> floors of the New Addition
    - Restricts pedestrian traffic flow

## Analysis 2: New Addition Foundation System

- Spread footings as the foundation system for the New Addition is not recommended
  - Space constraints of East Courtyard
  - Designed spread footings located up against existing spread footings

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## Analysis 3: 3D Laser Scanning Implementation

- 3D Laser Scanning is recommended
  - GSA should purchase and maintain equipment instead of renting the process

## Analysis 4: Operation and Maintenance of Energy

- Implementation of Building Dashboard is not recommended at this time
  - Relies solely on occupant behavior
  - Only as good as the engagement programs that integrate it
  - More long-term studies need to be conducted
  - Cost of implementation is unknown at this time





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The Pennsylvania State University AE Faculty  
Dr. Chimay Anumba

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Dean Smith – GSA Project Executive  
Justin Purcell – Heery International Project Engineer  
PACE Industry Members  
Family and Friends





# QUESTIONS

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