2011

GLOBAL VASCULAR INSTITUTE
BUFFALO, NY

Madison Smith
CONSTRUCTION MANAGEMENT
Dr. Riley

SENIOR THESIS FINAL REPORT

GLOBAL VASCULAR INSTITUTE

BUFFALO, NY

MADISON SMITH | CONSTRUCTION MANAGEMENT | http://www.engr.psu.edu/ae/thesis/portfolios/2011/mns5028/index.html

PROJECT OVERVIEW

USE: HOSPITAL & MEDICAL RESEARCH

SIZE: 450,000 SF

HEIGHT: 10 STORIES

CONSTRUCTION DATES: SEPT. 2009 - DEC 2011

CONSTRUCTION COST: ~$291,000,000, GMP

DELIVERY METHOD: CM AT RISK

PROJECT TEAM

OWNER:	KALEIDA HEALTH
OWNER:	UNIVERSITY AT BUFFALO
CM:	TURNER CONSTRUCTION COMPANY
ARCHITECT:	CANNON DESIGN
ENGINEER:	CANNON DESIGN

ELECTRICAL SYSTEM

THE POWER IS SUPPLIED BY NATIONAL GRID.

PRIMARY DISTRIBUTION: STEPPED DOWN TO 5000/6650V THROUGH 4 AA/FA OIL-FILLED POWER TRANSFORMERS AND DISTRIBUTED TO 2 5kV, 1200A, 300 MVA FAULT RATED DOUBLE-ENDED SWITCHGEAR.

SECONDARY DISTRIBUTION: 2 DOUBLE-ENDED 480Y/277V 3 PHASE, 4 WIRE + GROUND

MECHANICAL SYSTEM

VARIABLE AIR VOLUME SYSTEM FOR EACH FLOOR

(9) AHU'S RANGING FROM 28,000CFM TO 45,000CFM

SINGLE ZONE SYSTEM FOR ELEVATORS AND STAIRCASES

(7) AHU'S RANGING FROM 15,000CFM TO 25,000CFM

COOLING IS SUPPLIED FROM EXISTING CHILLER PLANT

(3) CENTRIFUGAL TRANE CHILLERS

NOMINAL CAPACITY: (1) 1400 TONS (2)2400 TONS

(3) ROOF MOUNTED INDUCED DRAFT COOLING TOWERS

NOMINAL CAPACITY: 7200 GPM

ARCHITECTURE

THE FAÇADE IS COMPOSED OF A CURTAIN WALL SYSTEM MADE UP OF LOW-E INSULATING GLASS AND PAINTED ALUMINUM PANELS. COMPARED TO MOST RECTANGULER STRUCTURES IN THE DOWNTOWN BUFFALO AREA, THIS STRUCTURE HAS DOMINANT CURVED EDGES ALONG THE NORTH - SOUTH DIRECTION OF THE BUILDING. A 5-STORY LINK CONNECTS THE NEW GVI BUILDING AND THE EXISTING BUFFALO GENERAL HOSPITAL.

STRUCTURAL SYSTEM

FOUNDATION: ENGINEERED FILL MATERIAL FOR SUBGRADE
STEEL H PILES ON LIMESTONE BEDROCK, PILE CAPS, GRADE BEAMS, SLAB-ON-GRADE

STRUCTURE: MOMENT FRAMING ON EXTERIOR
STEEL COLUMNS/BEAMS
STEEL/CONCRETE STEEL DECK COMPOSTIE
4 1/2" NWC, 3" DEEP 18 GAGE COMPOSITE STEEL DECK

FAÇADE: PAINTED ALUMINUM PANEL CURTAIN WALL

ROOF: 1 1/2" DEEP 18 GAGE TYPE B STEEL ROOF DECK
SUPPORTED ON TYPICAL BEAM, GIRDER, COLUMN CONSTRUCTION

SENIOR THESIS FINAL REPORT

MADISON SMITH – CM

1.0 EXECUTIVE SUMMARY

Senior Thesis Final Report is designed to discuss the findings and conclusions of the four analyses performed on the Global Vascular Institute. This project includes a 450,000 SF hospital/medical research facility and a 14,735 SF Link connecting the new construction to the existing Buffalo General Hospital. All of the analyses are intended to focus on the critical industry issue of improving efficiency in the construction industry.

ANALYSIS #1: Feasibility and Design Study for Photovoltaic Energy System

Due to the complexities of the function of the Global Vascular Institute, extremely high amounts of energy are needed to keep this building fully functional. The focus of this analysis was to design an appropriate façade photovoltaic system and to perform a feasibility study on that system. This analysis showed that the top 19170SF of the South façade was the best space to be utilized to construct the PV array. A preliminary structural analysis revealed that the photovoltaic system would actually be less of a structural load on the South façade of the building by 6,450lbs. With the use of rebate and incentive programs within New York State, the feasibility study determined that the PV system would recoup initial installation and material costs within 24 years of start-up.

ANALYSIS #2: Elimination of Inefficiency Through the use of Prefabricated Façade Panels

The design of the Global Vascular Institute is quite unique to any other building in the general area of this project. Its façade is designed so that the entire North and South facades are clad with horizontal rows of aluminum metal panels and glass while the East and West facades are all glass panels. The process of installing each of these panels was very time consuming and creates a lot of congestion for the already small site. This analysis showed that by prefabricating the East and West facades, the overall on-site schedule for the façade installation was greatly reduced. The results of this analysis determined that there is a 91 day savings in installation time with the use of prefabrication. The additional cost required to implement prefabrication for the façade is $357,210 which is about .12% of the entire cost of the project.

ANALYSIS #3: LEED Certification

At the completion of the Global Vascular Institute project, a LEED Certification will not be pursued. This decision was made during the schematic phase because of budgetary reasons. Upon completing a point-by-point analysis, it was determined that the original design Global Vascular Institute would obtain 46 out of 110 LEED points. This is enough for the project to achieve a LEED Certified rating because it is greater than the 40 points required. To become LEED Silver, 50 points are required, for LEED Gold, 60 points are required, and for LEED Platinum, 80 points are required. From the point-by-point analysis, it was determined which was the cheapest way to obtain each rating by mixing and matching the cost of different points from each credit category.

2.0 ACKNOWLEDGMENTS

Academic Acknowledgments:

Penn State AE Faculty

Dr. David Riley – CM Advisor

Industry Acknowledgments:

Turner

CANNONDESIGN

Special Thanks To:

Mark Dowling at Turner Construction Company

Global Vascular Institute Project Team

PACE Industry Members

My Family and Friends

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3.0 PROJECT OVERVIEW

3.1 Introduction

The Global Vascular Institute is a 450,000 square foot medical research/hospital facility located in Buffalo, NY. Substantial completion of the project is set for December 2012. The Global Vascular Institute is an extension of the existing Buffalo General Hospital located on High Street in Buffalo. The new medical facility consists of four floors of Kaleida Health's heart, vascular, and neurosurgery operations. It also has four floors of University of Buffalo's clinical translational research center. An expanded emergency room is also included.

Compared to the usual "Buffalo beige" box shape of most downtown Buffalo high rise buildings, the Global Vascular Institute has a more modern design consisting of curved edges, glass curtain walls and metallic grey painted aluminum panels. The design also can be described as being made up of blocks of space. Figure 1 below shows that the building is comprised of 3 separate blocks connected by glass panels, as well as the curvature of the edges of the building.

Figure 1: Architect's rendering of the Global Vascular Institute

GENERAL BUILDING INFORMATION	
BUILDING NAME	Global Vascular Institute
LOCATION	100 High Street Buffalo, NY 14203
OCCUPANCY	Hospital
GROSS BUILDING AREA	450,000 SF
NUMBER OF STORIES	10 Stories (half of lower level below grade)
CONSTRUCTION DATES	9/1/2009 – 10/14/12
CONTRACTED GMP AMOUNT	$291,000,000
PROJECT DELVIERY METHOD	CM at Risk

Table 1: General Information about the Global Vascular Institute

3.2 Project Location

The site for the Global Vascular Institute is located at the center of multiple medical facilities in downtown Buffalo, NY. GVI is located directly north of the existing Buffalo General Hospital. Part of the construction of the GVI project is to create a 4 story link between the existing and new structure. The project is also two blocks north of the Roswell Park Cancer Institute which is a cancer research facility. Directly east of the GVI site is the Central Power Plant which supplies power to Buffalo General Hospital and will also supply power to GVI. Adjacent to the Central Plant and across the street (Ellicott St.) to the west of the GVI site are parking areas that are available to use during the construction of the project. See **APPENDIX A** for the existing conditions site plan.

Figure 2: Google Map Image of GVI Site and Surrounding Area

3.3 Client Information

Kaleida Health and the University at Buffalo (UB) are co-owners of the Global Vascular Institute. Kaleida Health is the largest health care provider in Western New York. The largest hospital in its medical system is Buffalo General Hospital, which will become linked to the new

GVI building. The University at Buffalo is state university located in Buffalo, New York and has medical department. Each owner will occupy 4 floors; Kaleida on the lower 4 and UB on the upper 4. Kaleida Health will be using the space for heart, vascular, and neurosurgery operations with an expanded emergency room. UB will have a clinical translational research center occupying its space. This will become part of the medical program at the University. Both of these owners required this new building for growth of their business and development of their technologies.

The cost and quality are of the upmost importance for both owners. The project is partially sate funded so staying on budget is vital. The quality is critical as well because this facility is being built for extremely detailed surgeries to be performed. The standards that are required for ventilation and vibration proof rooms are detrimental to the success of the building. The standards of safety are also very important for the construction of this project. There is a scheduled substantial completion date set for the end of December 2011 but this is not close-ended. This allows for safety to always remain a high priority.

There will be no phased occupancy of the building during the construction of the project. Both owners will move in to the building after substantial completion.

3.4 Project Delivery Method

The project delivery method for the Global Vascular Institute is **Design-Bid-Build** with a **CM at Risk.** As a CM at risk system, the owner has a contract with the Architect/Engineer firm (Cannon Design) and a contract with the Construction Manager (Turner Construction). Turner Construction holds all the contracts with the prime contractors and will perform none of the work directly. Turner Construction's contract type with the owner is a guaranteed maximum price (GMP). For this type of contract in most cases, if the project is finished under the GMP, there is a sharing of savings between the owner and the construction manager. For

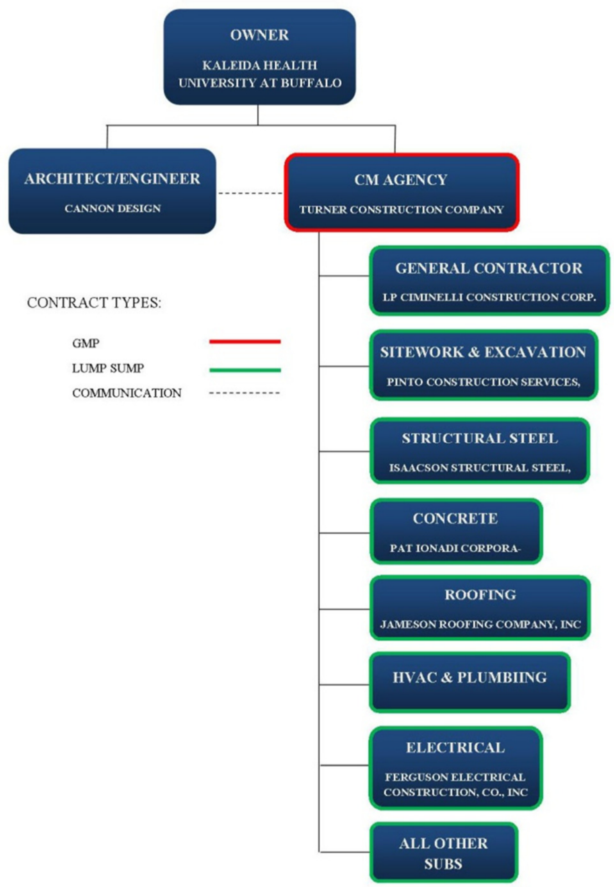


Figure 3: Project Organizational Chart

the Global Vascular Institute though, any savings below the GMP must go back to the owner. The insurance is an OCIP (Owner Controlled Insurance Policy), so the owner will be providing the insurance for the project. This insurance will include builder's risk, on-site GL, auto, and workman's compensation. Turner will provide insurance for off-site GL and auto. Turner holds lump sum contracts with all of the prime contractors that were selected based on the lowest and most qualified bid.

3.5 Project Team Staffing Plan

The organization of the staff for the Global Vascular Institute by Turner Construction is a traditional setup. It consists of three major staff divisions all reporting back to the project executive. The major divisions include a senior project manager, a safety manager, and a senior superintendent. Each of these divisions is then broken up further, as can be seen Figure 4.

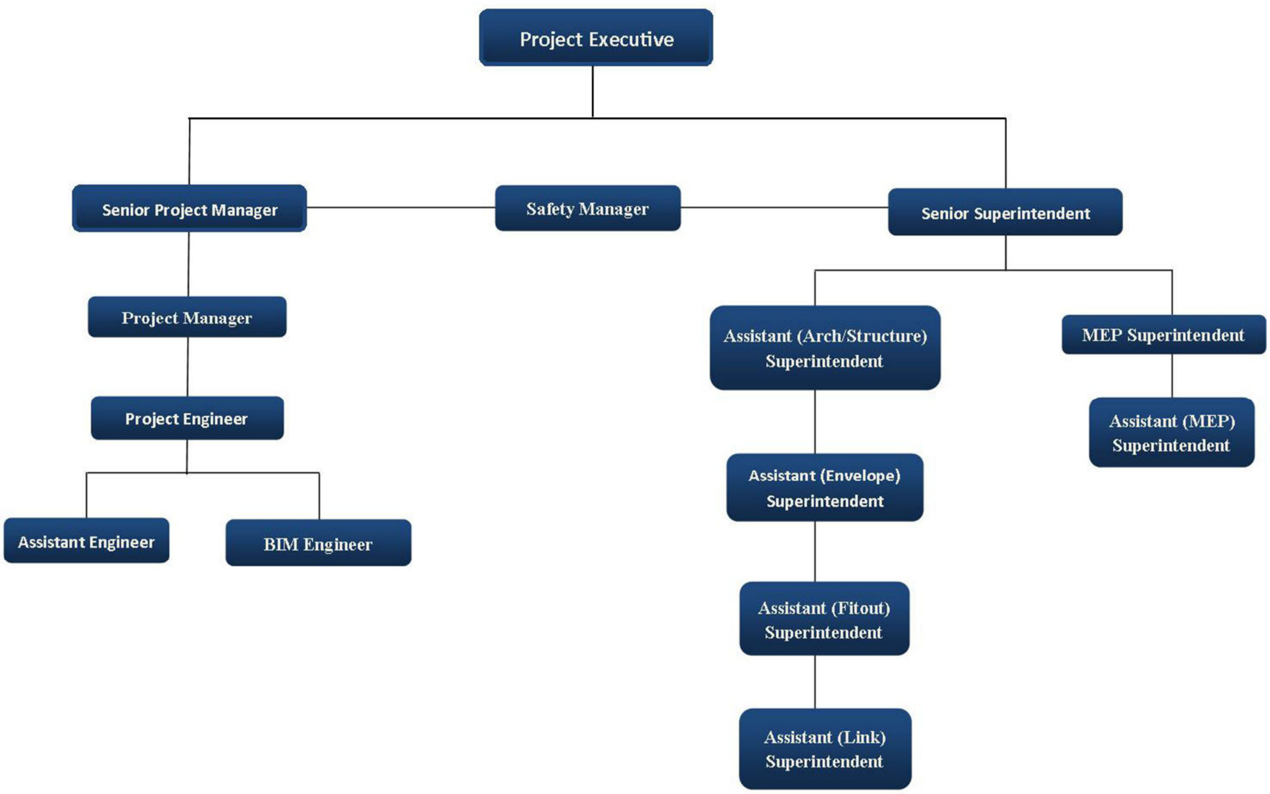


Figure 4: CM Staffing Plan

On this project, the project management staff is located in the Turner office. For this project, Turner was allowed to occupy offices during the duration of the construction, located in Buffalo General Hospital which is the existing hospital that the Global Vascular Institute will be connecting into. The field staff is located on the jobsite directly with the use of multiple field trailers. Since the management staff is located so closely to the jobsite, there is great communication between these two divisions. A safety manager is also involved on this project and has direct contact with both the management staff and the field staff, as well as with the project executive.

4.0 DESIGN AND CONSTRUCTION OVERVIEW

4.1 Building Systems

4.1.1 Demolition

The existing Buffalo General Hospital mental health facility located on the GVI site was demolished prior to the approval of City and State officials to construct the new Global Vascular Institute. Once approvals were obtained, some additional demolition is required. None of the demolition requires the removal of asbestos or lead paint.

Core Building

For the core GVI site, this will include concrete sidewalks, curbing, retaining walls, concrete pads, brick pavers, asphalt pavement, landscaping, sewer structures and piping, light poles, and conduit.

Link

For the link between the new GVI building and the existing Buffalo General Hospital, demolition is required on a segment of the Buffalo General Hospital. This link is connecting to Buffalo General Hospital at a side entrance to the building. A few major items to be removed from this area will be an existing stairs, elevator and elevator shaft. In addition, the exterior wall from the first level to the third floor level will also be removed. This consists of an aluminum window system and E.I.F.S. and brick exterior walls. This area can be seen highlighted in red in figure 5.

Figure 5: 1st Floor Demolition Plan of the Link

Demolition is also required on the sub-basement and basement levels. Some additional materials that need to be removed throughout the entire link area include CMU partitions, doors, windows, carpeting, acoustic ceiling tiles, wall mounted signs, terrazzo flooring, HVAC equipment, plumbing utilities, vents, fans, interior/exterior concrete slabs, and concrete curbs.

Central Plant

There is also demolition required at two exterior locations around the central plant; the Northeast corner and the Southwest corner. Materials to be removed include sidewalks, silo foundations, concrete stairs and retaining walls, light fixtures, mechanical equipment, asphalt paving, electrical utilities, overhead door, and glass/aluminum storefront system.

4.1.2 Structural Steel Frame

The structural system of GVI is a structural steel framing system. The structural steel framing system will be built up on a pile/pile cap and grade beam foundation. The building will be constructed with an 8 x 8 column grid. Figure 6 shows a typical framing floor plan. Table 2 shows the size of the structural steel beams used on each floor. (More sizes than those noted are used on each floor. Only a general breakdown is shown.) The column sizes used per floor are much more varied than the beams sizes. The columns are spliced every 2 floors.

Structural Steel Beam Table	
Steel Beam Size	Level
W18x40	Basement
W16x31	1
W18x40	2
W18x40 W33x118	3
W18x40 W21x44	4
W21x44	5
W27x84	6
W33x118 W21x44	7
W21x44 W27x94	8
W18x35 W24x62	9
W16x31 W18x50	Roof

Table 2: Steel Beam Schedule

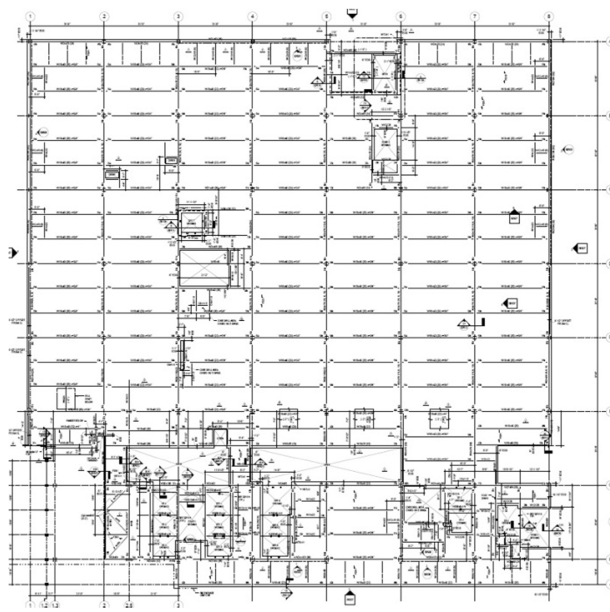


Figure 6: Typical Framing Plan

A moment frame system is used along the perimeter of the building. Braced frames are used along the gridlines. Figure 7 shows one of the exterior framing elevations.

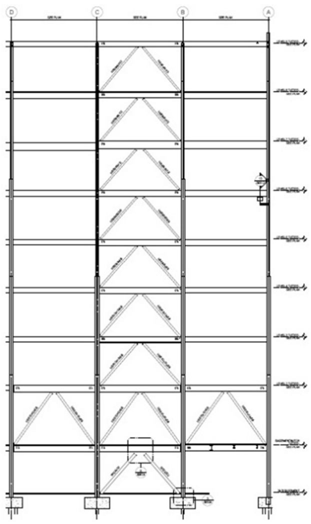


Figure 7: Braced Frame of Gridline 1

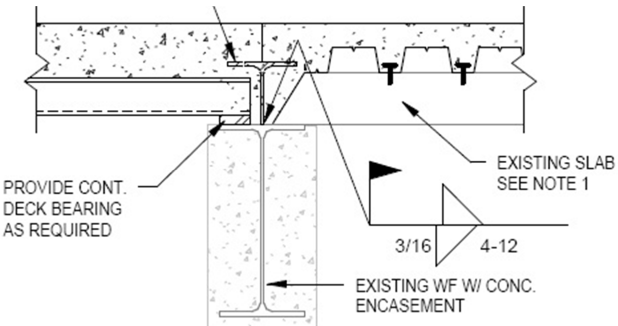


Figure 8: Typical Composite Floor Slab

Composite steel floor slabs are used throughout the building. As shown in Figure 8. They consist of 4 ½” NWC on 3" deep, 18 Gage composite steel deck.

4.1.3 Cast-In-Place Concrete

Cast-in-place concrete will be reinforced and used for pile caps, foundation walls, grade beams, SOG, concrete tunnel from GVI core building to the central plant and in composite deck construction.

4.1.4 Precast Concrete

Precast concrete panels are used on the exterior of the building on ground level as can be seen in figure 9a, 9b, and 9c. The areas of precast concrete are highlighted in green. There is also a small area of precast concrete panels located on the south exterior elevation as well. The panels will be finished with a radius texture with a 3/16” grout joint between panels.

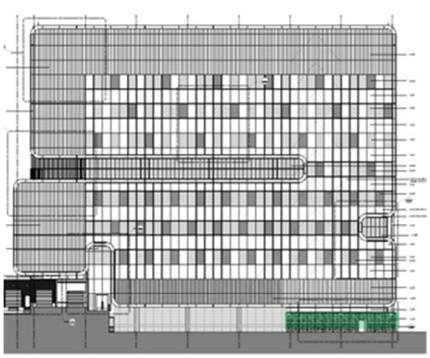


Figure 9a: East Exterior Elevation

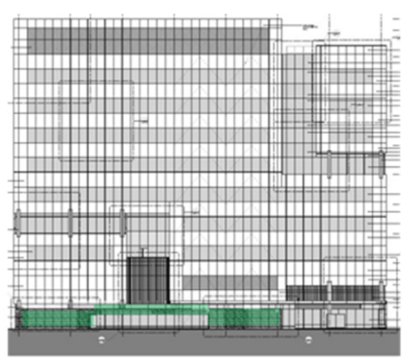


Figure 9b: North Exterior Elevation

Figure 9c: West Exterior Elevation

4.1.5 Mechanical System

There are two mechanical rooms located in the core GVI building. They are located from the basement level to the 2nd level, as well as from the 8th level to the roof, as can be seen in figure 10. The mechanical system type used is Variable Air Volume (VAV) and single zone. These systems will be supplied by air-handling units located in the basement and in the Penthouse mechanical room. Table 3 describes the location of each AHU, where it supplies to and the type of system that AHU uses.

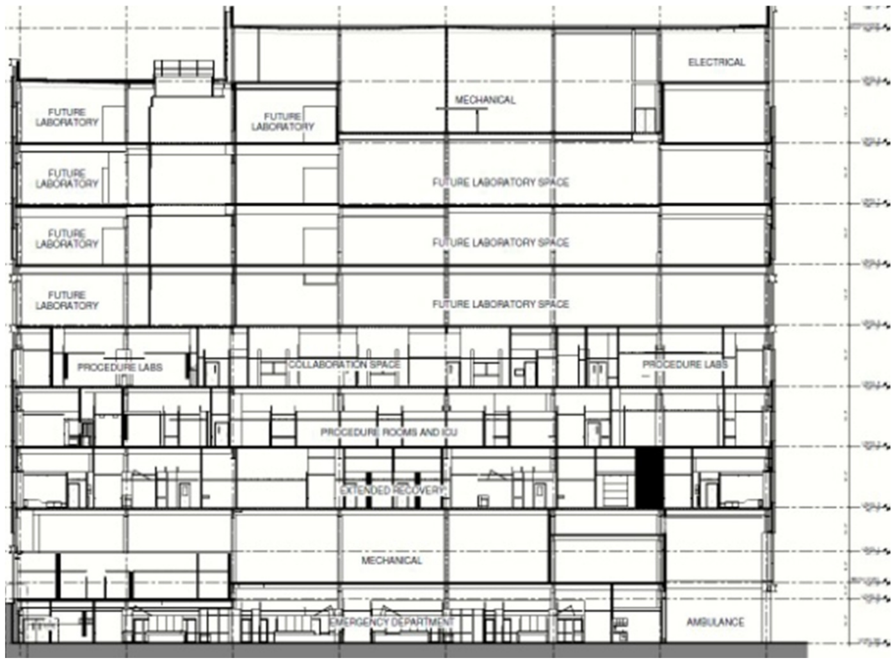


Figure 10: Floor Usage Section

The central plant will house the required 3 chillers and 2 cooling towers for GVI. Two of the existing chillers will be replaced with two nominal 2400 ton dual compressor centrifugal chiller systems and two of the existing cooling towers will be replaced with two nominal 7200gpm cooling towers. To distribute chilled water to GVI, a new 10'x10' concrete tunnel will be constructed from the central plant to GVI. The tunnel will connect to GVI at the Basement Level Mechanical room. A 16" chilled water supply pipe will run through this tunnel to supply GVI with chilled water with a 24" return pipe to the central plant. The central plant will supply high pressure steam to GVI as well. No new boilers will new to be added or replaced. The two existing boilers discharge 85psi steam and are 60,000lb/h and 30,000lb/h. The tunnel will also house the 18" high pressure steam main to GVI. At the basement mechanical room, the main will split into a 12" main to supply Buffalo General Hospital and an 8" main to supply GVI.

Mechanical Systems Breakdown			
AHU No.	Service Area	Location	System Type
OR-1	Procedure Room Level 2, 3	Basement MER	VAV
OR-2	Procedure Room Level 2, 3	Basement MER	VAV
OR-3	Procedure Room Level 2, 3	Basement MER	VAV
HOTEL/ICU-1	Hotel & ICU Level 1, 2, 3	Basement MER	VAV
HOTEL/ICU-2	Hotel & ICU Level 1, 2, 3	Basement MER	VAV
ED-1	Emergency Department Level SB	Basement MER	VAV
ED-2	Emergency Department Level SB	Basement MER	VAV
CORE-1	South Core Levels SB, B,1,2,3	Basement MER	VAV
LINK-1	Link Levels B, 1,2,3	Roof of Link	VAV
ELEV-P-1	Elevator Shaft Pressurization	Penthouse MER	Single Zone
ELEV-P-2	Elevator Shaft Pressurization	Penthouse MER	Single Zone
ELEV-P-3	Elevator Shaft Pressurization	Penthouse MER	Single Zone
ELEV-P-4	Elevator Shaft Pressurization	Penthouse MER	Single Zone
STAIR-1	Stairwells	Penthouse MER	Single Zone
STAIR-2	Stairwells	Penthouse MER	Single Zone
STAIR-3	Stairwells	Penthouse MER	Single Zone
ANIM-1	Vivarium	Penthouse MER	VAV
ANIM-2	Vivarium (standby)	Penthouse MER	VAV
LAB-1	Wet Labs	Penthouse MER	VAV
LAB-2	Wet Labs	Penthouse MER	VAV
LAB-3	Wet Labs	Penthouse MER	VAV
OFF-1	Offices & Meeting Spaces	Penthouse MER	VAV
OFF-2	Offices & Meeting Spaces	Penthouse MER	VAV
OFF-3	Offices & Meeting Spaces	Penthouse MER	VAV
CORE-2	South Core Levels 4,5,6,7,8	Penthouse MER	VAV

Table 3: Mechanical Systems Breakdown

A zoned sprinkler system by floor will be used. There will be a floor control valve with tamper switch and flow switch for each riser and for each zone. The entire building will consist of a wet standpipe and sprinkler system.

4.1.6 Electrical System

National Grid supplies the electrical service for GVI. A new substation will be constructed at the central plant. It will consist of four 5000/6650 kVA AA/FA oil-filler power transformers and two double-ended switchgear assemblies rated 5kV, 1200A, 350 MVA fault rating.

For the GVI building, two double-ended 480Y/277 V unit substations will be constructed. One will be located in the main electrical room on level B and the other will be in the penthouse electrical room. Refer to figure 9 for locations. Each unit substation will be 480V, 3 phase, 4 wire, plus ground. This will then be further transformed down to 208Y/120 V, 3 phase, 4 wire, plus ground. This lower voltage will mostly be used for receptacles and miscellaneous equipment.

Three new 2,000kW, 480V stand-by rated diesel generators will be installed in addition to the existing (1) 765kW Detroit Diesel, (2) 750kW Onan diesel, and (1) 500kW Caterpillar diesel generators.

4.1.7 Curtain Wall

The curtain wall system is comprised of Low-E glass and painted aluminum panels. The use of glass and aluminum are used in horizontal stripes around the building for the North and South façade. The East and West sides are composed of almost all glass. A section of the curtain wall is shown in figure 11. This composition is also used for the exterior of the Link.

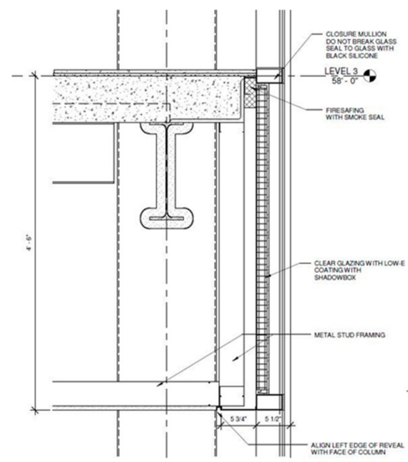


Figure 11: Wall Section of Curtain Wall

4.1.8 Support of Excavation

A limited amount of excavation is required for GVI. The major foundation system used is piles which will just be driven down into the soil. Only one story of the building will be partially below grade. The type of support will be soldier piles with lagging. The location of the shoring is shown in figure 12, marked by the dashed green line.

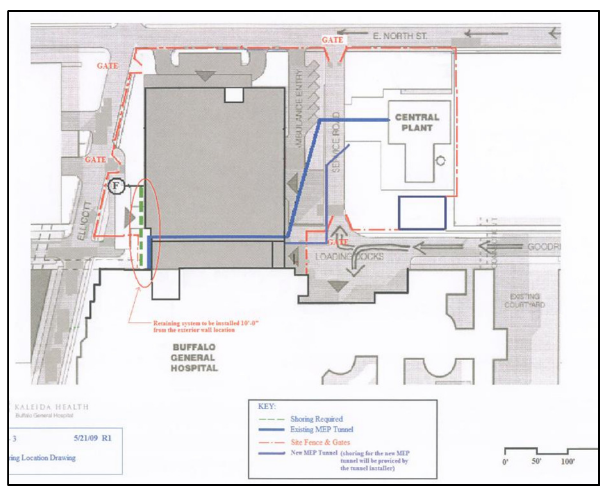


Figure 12: Shoring Layout

4.2 Project Cost

The actual construction costs are based on the GMP calculations provided by Turner Construction Company. The amounts do not represent actual bid costs on the project but are reflective of the Design Development Budget.

PROJECT PARAMETERS

Square Footage of Building:	450,000 SF
Building Perimeter:	900 LF

CONSTRUCTION COST (Actual)

Actual:	$146,863,897
Per SF:	$309.45

TOTAL PROJECT COST

Actual:	$171,459,163
Per SF:	$381.33

MAJOR BUILDING SYSTEM COST ESTIMATE

BUILDING SYSTEM COST		
SYSTEM	**ACTUAL**	**COST/SF**
Concrete	**$7,867,215**	**$16.58**
Masonry	**$301,009**	**$0.63**
Metals	**$19,628,663**	**$41.35**
Wood & Plastics	**$2,861,450**	**$6.03**
Thermal & Moisture Protection	**$3,709,845**	**$7.82**
Doors & Windows	**$18,277,446**	**$38.51**
Finishes	**$14,013,284**	**$29.53**
Specialties	**$1,874,294**	**$3.95**
Equipment	**$270,000**	**$0.57**
Furnishings	**$80,000**	**$0.17**
Conveying Systems	**$4,438,049**	**$9.35**
Fire Suppression	**$2,610,425**	**$5.50**
Plumbing	**$7,007,530**	**$14.77**
Mechanical	**$28,855,666**	**$60.80**
Electrical	**$25,453,347**	**$53.63**
Earthwork	**$5,170,685**	**$10.89**
Exterior Improvements	**$1,069,720**	**$2.25**
Utilities	**$799,738**	**$1.69**
Transportation	**$94,000**	**$0.20**

Table 4: Building Systems Breakdown

4.3 Local Conditions

The Global Vascular Institute is located in the center of Buffalo, NY, in the medical district. This will cause some construction difficulty because Buffalo General Hospital must remain open and functional throughout the entire construction of GVI. Since the project is in a major city, obtaining an available skilled labor force for the construction will not be a problem.

Parking fortunately is not a major issue on the project because there is a parking deck located right across the street from the site. There is also an additional parking lot next the central plant that is owned By Kaleida Health, an owner of the building.

Buffalo, NY has mild summers with relatively low humidity. The winters however can be quite extreme. The project site is located very close the Lake Erie so during the winter months there is a high risk of "lake effect snow" which could cause huge amounts of snow fall in a very short amount of time. This could cause both time delays as well as causing structural issues if there are high snow loads on the structure before it has been fully constructed. For construction below the water table, well points or cofferdams will be used to create dry conditions.

4.4 Detailed Project Schedule

See APPENDIX B for the Detailed Project Schedule.

The Global Vascular Institute project consists of three major components which include the main GVI core building, the link between the GVI core and the existing Buffalo General Hospital, and additions to the adjacent central power plant. All three of these components are sequenced to be constructed at the same time. The schedule in APPENDIX A is broken down so that each of the three components individual schedules is separated from the others. The central plant schedule is then broken down further into three sections for each of the addition areas of the building. All major milestones of the project are shown in Table 5.

The first phase of the project was to demolish the existing 4 story community mental health clinic that was on the core building site. This phase was completed prior to the approval from the City of Buffalo and the State of New York to perform the new construction of GVI. With the site cleared and receiving the notice to proceed on July 7, 2009, the next major phase was excavation work. This was scheduled to begin in September 2009 and to be completed by November 2009. Additional excavation for the central plant utility tunnel was set to begin in February 2010 and take only 4 days to complete. Foundation work was planned to begin during the excavation phase and continue till February 2010. This consists of piles, piles caps, grade beams. The foundation work for the central plant though would not begin until January 2010.

The first major milestone after the notice to proceed was to mobilize the crane for the erection of steel on January 11, 2010 with the process of the superstructure construction being scheduled to top off in July 2010. During this phase, enclosure work began in July with the milestone of a dry building to be accomplished in November 2010. Rough-In and finish work began in June and will continue until May 2011. After testing/balance and the punch lists being performed from September 2011 to October 2011, substantial completion and turnover of the sub-basement to level three of the building is set for October 2011. This is required by the owner so that operations between GVI and Buffalo General Hospital can begin to be coordinated. Turnover and Occupancy of the building is set for December 2011. See Appendix A for the Project Summary Schedule.

MILESTONE	DATE
Notice to Proceed	7/7/2009
Top Out	7/13/2010
Building Dry	11/30/2010
Substantial Completion (1st)	10/17/2011
Substantial Completion (Final)	12/12/2011

Table 5: List of Milestones and Dates

4.5 Site Layout Planning

See APPENDIX C for the Site Layout Plans

Figure 13: Google Map Image of GVI Site and Surrounding Area

The site for the Global Vascular Institute is located at the center of multiple medical facilities in downtown Buffalo, NY, as shown above in Figure 13. GVI is located directly north of the existing Buffalo General Hospital. Part of the construction of the GVI project is to create a 4 story link between the existing and new structure. The project is also two blocks north of the Roswell Park Cancer Institute which is a cancer research facility. Directly east of the GVI site is the Central Power Plant which supplies power to Buffalo General Hospital and will also supply power to GVI. Adjacent to the Central Plant and across the street (Ellicott St.) to the west of the GVI site are parking areas that are available to use during the construction of the project.

EXCAVATION SITE LAYOUT

Due to all of the nearby existing structures, the size of the available space on the site is limited. All of the trailers are located along the edges of the site so that they are easily accessible to the trades. The excavation will proceed from the South-West corner of the site to the North-East corner. This will allow less congestion and increased flow through the site since the trucks will be entering the site from the west and exiting to the East. The soil stockpile is located near the exit as well so that the equipment performing the excavation can follow the flow pattern of the site and will not block the entrance. Additional material storage is located in the South-East corner so that it is easily accessible to all three of the structures of the project and remains out of the way of the equipment. ***See Appendix C for Excavation Phase Site Plan.***

SUPERSTRUCTURE SITE LAYOUT

Due to the limited open space of the site, the most beneficial location for the tower crane is to have it located along the East side of the building. This will allow the crane to reach the entire core building area and the link building area. The trailers will remain in the same location as those of the excavation phase, but just of different trades. The soil stockpile space will be replaced by steel shakeout due to that space being the largest open space available on the site. Additional material storage will remain in the same location as in the excavation phase since it is centrally located between the three components. ***See Appendix C for Superstructure Phase Site Plan.***

4.6 General Conditions Estimate

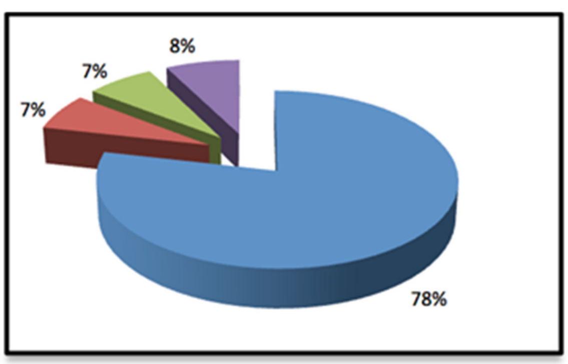
See APPENDIX D for the complete General Conditions Estimate.

Table 6 shows a summary of the line items of the general conditions estimate for the Global Vascular Institute. This summary is an approximation and does not reflect the actual costs of the general conditions agreed upon by Turner Construction Company.

LINE ITEM	UNIT	UNIT RATE	QUANTITY	TOTAL COST
Construction Manager Personnel	MONTH	$78,474.07	27	$2,118,800.00
Temporary Facilities	MONTH	$6,887.04	27	$185,950.00
Temporary Utilities	MONTH	$7,020.74	27	$189,560.00
Miscellaneous Costs	MONTH	$7,620.37	27	$205,750.00
			TOTAL:	**$2,700,060.00**

Table 6: General Conditions Estimate Summary

The general conditions estimate was broken down into four main categories which include, Construction Manager Personnel, Temporary Facilities, Temporary Utilities, and Miscellaneous Costs. Construction Manager Personnel includes the major players involved on the project from Turner Construction Company (construction manager). The Temporary Facilities consist of items such as the jobsite trailer, site fence, mobile phones, dumpsters, and signage. These are all items that are necessary for the construction management team to be able to work on and complete the project on time at the project site. The Temporary Utilities are the items that are necessary for functionality of the site. This includes items such as IT/Network service, power installation and consumption, and potable water. Lastly, the Miscellaneous Costs account for all other items that do not fall into any of the other categories. This would be things such as progress photographs, document reproduction, and travel expenses.



Construction Manager Personnel
Temporary Facilities
Temporary Utilities
Miscellaneous Costs

Figure 14: General Conditions Breakdown by Percent

Figure 14 depicts the breakdown of general conditions costs based on percentage. This shows that the vast majority, 78%, of the general conditions costs are from the construction manager personnel staffing costs.

5.0 FEASIBILITY AND DESIGN STUDY FOR PHOTOVOLTAIC ENERGY SYSTEM

5.1 Problem Identification

For the Global Vascular Institute to become fully functional, renovations must be completed to the adjacent central plant that will power the building. Overall, the energy costs for this project are very high due to the function of the building being a research facility as well as a hospital. The budget for this project was one on the major limiting factors in the design and scope of the building, so sustainable features were not thoroughly researched for incorporation into the design.

5.2 Research Goal

The goal of this analysis is to perform a preliminary design of a building integrated PV energy system and determine the financial feasibility to incorporate the system into the existing power plan to reduce energy costs for the owner.

5.3 Methodology

- Research PV panel technologies
- Contact PV panel manufacturers for design consultation
- Determine quantity and arrangement of panels on façade and amount of kWh able to be produced
- Analyze how the existing structure will be affected with added PV panels loads
- Analyze how the PV system will connect to the existing electrical power system
- Perform feasibility analysis on lifecycle cost and payback period

5.4 Background Information

As mentioned before in the problem identification, the Global Vascular Institute is both a medical research facility as well as a hospital. Because of this, this building will consume higher amounts of energy everyday than other commercial buildings due to the fact that it has powerful equipment always operating and is open 24 hours a day. As that this building is designed to be in operation for many years, a photovoltaic solar array is appealing to be incorporated into the building. This is because it may take a few years to get back the initial cost of the system and to reduce the electric bills significantly. The Global Vascular Institute did not consider the installation of a PV system due to the high initial cost. It is not expected that the PV system can provide all of the energy required for the building to fully operate but with the large façade space available, a large portion of the buildings energy consumption may be accounted for with this renewable energy source. In this analysis a new monolithic panel from Schüco will used.

Information about this product was obtained from a representative from Schüco as that it was not widely available yet.

5.5 Preliminary PV Array Design

5.5.1 Orientation and Shading

The orientation of the Global Vascular Institute is optimal for a façade PV array. Table 7 lists the key design parameters for the PV system. The buildings footprint is lined up so that the South façade is facing directly south. The 3.31 sun hours/day references Rochester, NY, a city 1 hour Northeast of Buffalo, NY and was obtained from energystar.gov. A *Google SketchUp* model was created to analyze the solar shading effects on the South façade of the building by adjacent buildings. Figures 15 - 17 show the solar shading on the South façade at 9AM and 4PM for the winter solstice, the fall/spring equinox and the summer solstice. As seen in the images, there is only slight shading of the South façade from adjacent buildings during the winter solstice months.

DESIGN PARAMETERS FOR PV SYSTEM	
Location	Buffalo, NY
Latitude	42* 53’ 11” N
Longitude	78* 52’ 43” W
Footprint Orientation	Directly North to South
Sun hours/day	3.31

Table 7: Design Parameters for Photovoltaic System

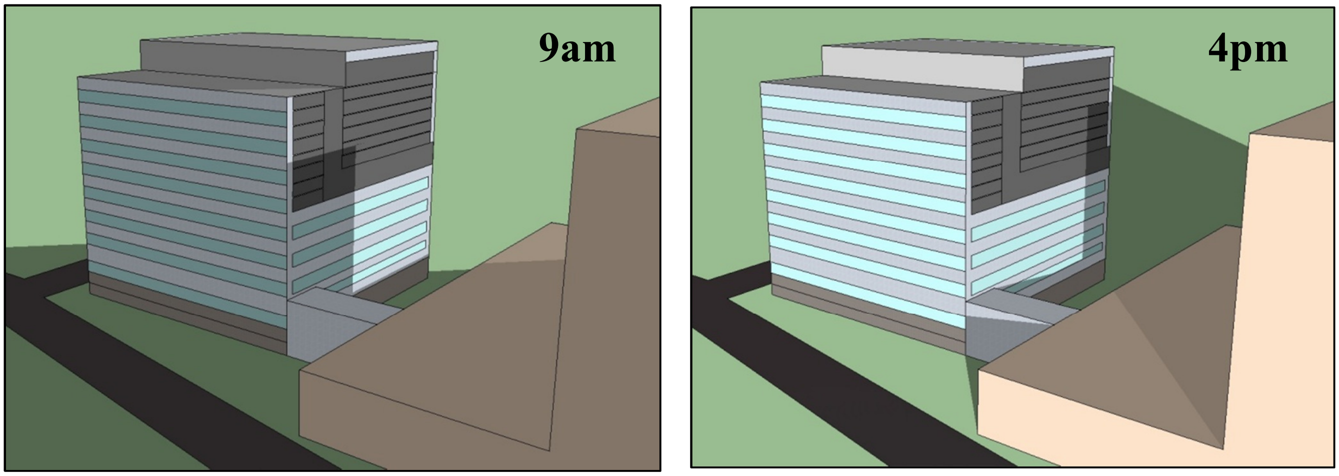


Figure 15: Winter Solstice Shading (December 21)

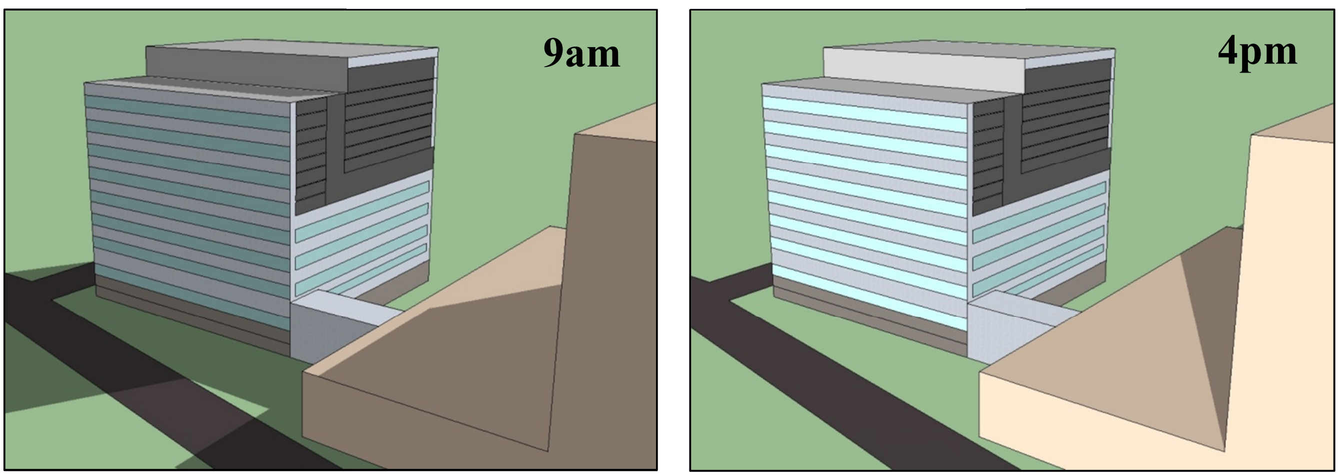


Figure 16: Fall/Spring Equinox Shading (March 20/September 22)

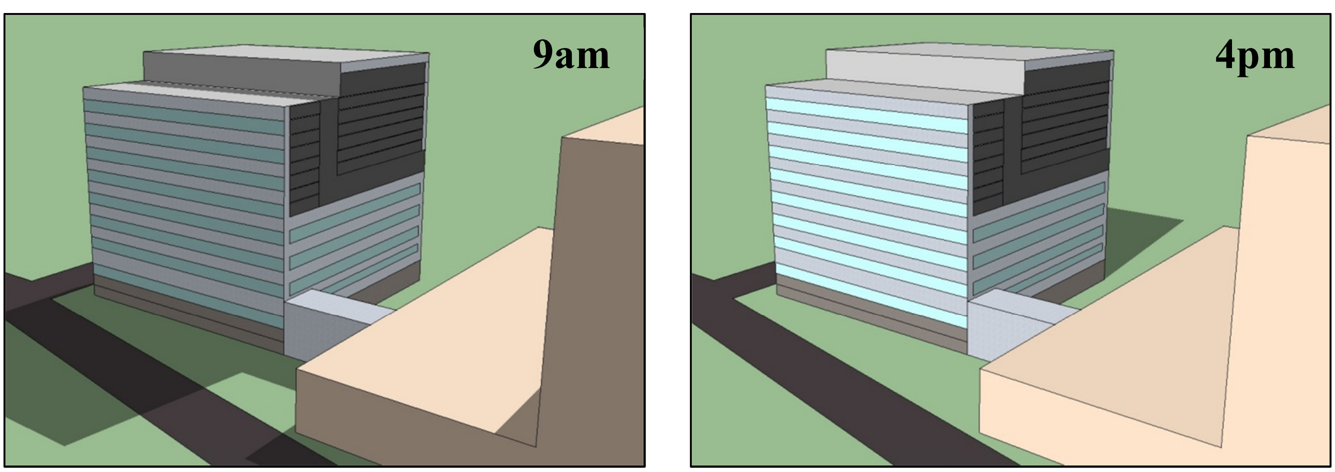


Figure 17: Summer Solstice Shading (June 20)

5.5.2 System Size and Layout

As mentioned in the section, orientation and shading, all of the PV panels were placed on the South façade of the building as that this side gets the most direct sun during the day. The panels were also placed only on the top half of the South façade due to the adjacent building creating a shadow casting a shadow on the lower half of the Global Vascular Institute. Figure 18 shows the layout of the PV panels on the South façade. The PV panels are indicated by the horizontal dark grey blocks. Table 8 lists the criteria of the PV panel layout design.

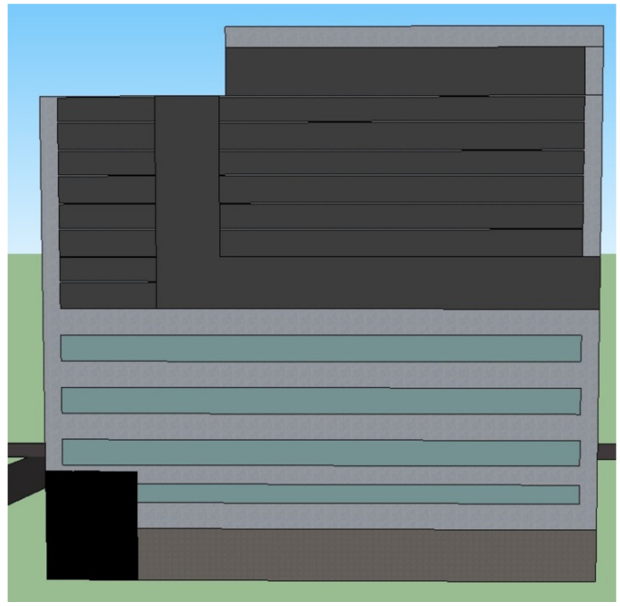


Figure 18: South Façade PV Panel Layout

SOLAR ARRAY CRITERIA	
Sun Hours Per Day	3.31
Size of Panel (SF)	54
Watts per SF	5
Actual Produced Power Per Panel (Watts)	270
# of Panels	426
Total Power Produced by Panels Per Day (Watts)	115,020

Table 8: PV Array Layout Information

5.6 Structural Breadth

To ensure that the Global Vascular Institute can support a façade photovoltaic system, a structural analysis of the South façade was performed. Table 9 shows the weight of the originally designed façade versus the weight of the façade with PV panels. For the original façade, there are 246 aluminum panels and 180 glass panels. Each aluminum panels weighs 140lbs and each glass panel weighs 590lbs.

WEIGHT OF ORIGINAL FAÇADE VS PV FACADE					
Façade Type	**Square Footage**	**Weight/SF (lbs/SF)**	**Weight of Aluminum Panels (lbs)**	**Weight of Glass Panels (lbs)**	**Total Weight (lbs)**
Original	19,170	-	34,440	106,200	140,640
PV Panels	19,170	7	-	-	134,190
			Weight Difference		**(6,450)**

Table 9: Breakdown of Façade Weight

From this comparison, there is a 6,450lbs decrease in weight will the photovoltaic system installed on the South façade of the Global Vascular Institute. This equates to a 2.97lbs/SF decrease in load on the façade. Because of this, no additional structural supports need to be put into place to support the load of the PV system.

Because of this reduction in overall weight of the PV system on the façade, the use of the PV system may allow for a reduction in the size of the steel beams use on the South façade. To analyze this in STAAD, the loads on each beam need to be calculated. Table 10 shows the calculated loads used per beam. Only bay 3-4 was modeled and analyzed in STAAD because of the similarity among all the bays on the South façade on the building.

DISTRIBUTED LOAD ON BEAMS					
Type	**Description**	**Load (PSF)**	**Tributary Area (SF)**	**Length (Feet)**	**Uniform load (lb/LF)**
Dead Load	Aluminum	1.55	567	31.5	28
Dead Load	PV	.55	567	31.5	12.5
Dead Load	Self-Weight	Specific to each beam			
Dead Load	Roof	20	-	-	-
Live Load	-	100	-	-	-

Table 10: Breakdown of the Uniform Loads on Each Beam in Bay 3-4

By using the calculated loads, the bay 3-4 was modeled and analyzed in STAAD Pro and the maximum deflections for the current façade, the PV façade and a reduction in beam size were determined. Table 11 shows the maximum deflection of each load case. ***See Appendix E for the deflection charts.***

BEAM DEFLECTION	
Load Case	**Max. Deflection**
Aluminum Façade	0.025
PV Façade	0.023
Reduced Size	0.025

Table 11: Beam Deflection for Bay 3-4 on South Façade

The results of this analysis show that by reducing the size of the beams, the same amount of deflection is obtained as the aluminum façade.

Reducing the beam size will also provide a savings in cost to the structure. Table 12 shows the cost savings by reducing the size of the beams.

SAVINGS DUE TO BEAM SIZE REDUCTION							
Floor	**Existing Beam Size**	**Cost/LF**	**Reduced Beam Size**	**Cost/LF**	**Savings/LF**	**Length (FT)**	**Total Savings**
1	W36x135	-	-	-	-	-	-
2	W24x68	-	-	-	-	-	-
3	W27x84	-	-	-	-	-	-
4	W24x68	-	-	-	-	-	-
5	W24x68	-	-	-	-	-	-
6	W24x68	-	-	-	-	-	-
7	W24x76	$111.00	W24x68	$100.00	$11.00	31.5	$346.50
8	W24x76	$111.00	W24x68	$100.00	$11.00	31.5	$346.50
9	W27x84	$121.00	W24x68	$100.00	$21.00	31.5	$661.50
10	W30x108	$154.00	W27x84	$121.00	$33.00	31.5	$1039.50
						Bay Savings	**$2,394.00**
						Total Façade Savings	**$16,758.00**

Table 12: Breakdown of the Savings Due to Reducing Beam Size

From the reduction in beam size for the South façade, there is an overall savings of $16,758 to the cost of the building. Compared to the overall cost of the project, this is a very insignificant savings.

5.7 Electrical Breadth

5.7.1 Energy Production

To determine the financial feasibility of the PV system, the yearly value of the energy produced needed to be calculated using the local conditions and the parameters for the array design. A yearly energy value of $11,393.95 was calculated by using the PVWatts calculator at pvwatts.org and the station identification information for Buffalo, NY which is shown in Table 13. The results from the PVWatts calculator are shown in Table 14. These results show that the yearly AC energy produced by the system is 78,579kWh/year.

STATION IDENTIFICATION	
City	Buffalo
State	New York
Latitude	42.93° N
Longitude	78.73° W
Elevation	215m
PV SYSTEM PARAMETERS	
DC Rating	115kW
DC to AC Derate Factor	.77
AC Rating	88.5kW
Array Type	Fixed
Array Tilt	90°
Array Azimuth	180°
ENERGY PARAMETERS	
Cost of Electricity	14.5 /kWh

Table 13: Station Identification

PV WATTS ENERGY PRODUCTION RESULTS			
MONTH	**SOLAR RADIATION ($kWh/m^2/day$)**	**AC ENERGY (kWh)**	**ENERGY VALUE ($)**
1	2.31	6473	$938.59
2	2.96	7644	$1108.38
3	3.39	9228	$1338.06
4	2.94	7133	$1034.29
5	2.84	6429	$932.21
6	2.63	5411	$784.60
7	2.72	5766	$836.07
8	3.09	7090	$1028.05
9	2.99	7005	$1015.73
10	2.77	7077	$1026.16
11	1.84	4519	$655.25
12	1.82	4806	$696.87
Year	**2.69**	**78,579**	**$11,393.95**

Table 14: Annual AC Production and PVWatts Factor

5.7.2 Electrical Components and System Tie-in

The main electrical components of the PV system are those that tie-in the system to the building. To tie-in the PV system to the electrical system of the Global vascular Institute, the PV panels need to be wired up in series together, positive to negative. These strings then need to be strung to together in parallel strings to an inverter so that the current is changed from DC to AC. From there, the inverter is tied to a breaker box and then to the main grid. Figure 19 below shows a portion of the PV panels array and how they are wired together in series and in parallel.

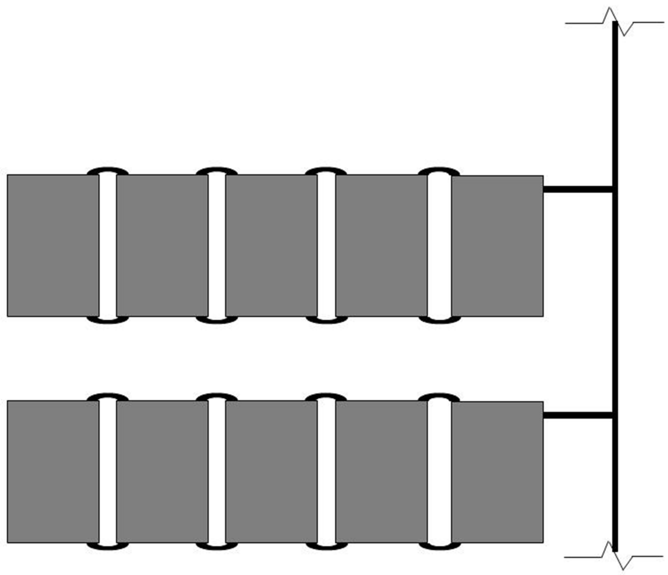


Figure 19: Portion of PV Panels Wired Together

Since the PV system is located on façade of the building and over a large area, there is a possibility of long DC wire runs to the electrical tie-in components, which could result in large voltage drops. This could be very costly to the project since DC wiring is much more expensive that AC wire. To minimize this, it was determined to locate the inverter in the 8th level electrical room along the South facade. The inverter selected for the PV system is the Fronius CL 60.0kW, which contains nine power modules that divide up the work. The total load for one of these inverters is 60kw, so to fulfill the total load for the PV system two of these inverters will be used. This will attain a combined power rating of 120kW which is greater than the 115kW required for the entire system. The electrical room that these inverters will be placed takes up most of that floor level, so there would be plenty of room to fit the inverters. ***See APPENDIX F for the inverter product data.***

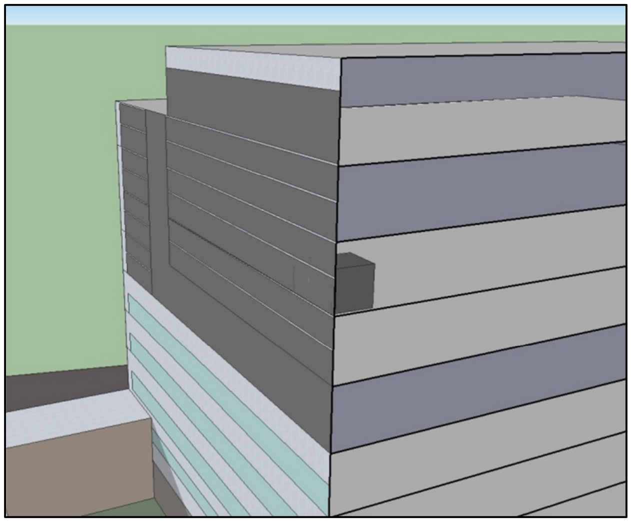


Figure 20: Inverter Location in 8th Floor Electrical Room

Figure 20 above shows the location of the inverters in the electrical room. The inverters will then connect into the breaker box and from the electrical room; AC wire will run down the building to the utility power supply feed that enters the building through the sub-basement level.

5.8 Feasibility Analysis

5.8.1 System Cost

To determine the feasibility of the photovoltaic system, an approximate cost for the array was calculated using information from multiple sources reporting an average cost per watt estimate for a photovoltaic system. Table 15 shows the estimated cost of the 115kW photovoltaic system for the Global Vascular Institute.

ESTIMATED COST OF PV SYSTEM		
Size (kW)	**$/W**	**Cost**
115	$10.00	$1,150,000

Table 15: Estimated PV Array Cost

Since the PV system is being installed on the façade of the building and replacing a portion of the curtain wall, the cost of that portion of the façade can be subtracted out of the cost of the PV system to determine the additional cost to the project. The actual additional cost to the project is shown in table 16 on the next page. The cost of original façade comes from a cost of $1400 per aluminum panel and $25/SF for the glass panels.

ACTUAL COST OF PV SYSTEM	
Façade Type	**Overall Cost of System**
Original Façade	$546,900
PV Facade	$1,150,000
Cost Difference	**$603,100**

Table 16: Actual Cost of Photovoltaic System

5.8.2 Rebates and Incentives

Federal incentives offer Business Energy Investment Tax Credit (ITC) to a variety of renewable energy systems. For a PV system, 30% of the entire systems expenditures will be paid for with no limit. The New York State Energy Research and Development Authority (NYSERDA) provide a PV incentive Program for buildings that accounts for $1.75/watt. The maximum incentive that can be gained from this though is $87,500 for non-residential buildings. The NYSERDA also provide incentive programs for commercial sites that have PV systems of 50 kW or less. As that this system is 115 kW this Solar Electric Incentive Program does not apply. Table 17 shows the total savings from all of the applicable rebates and incentives for the Global Vascular Institute.

REBATES AND INCENTIVES				
Type	**Quantity**	**Limits**	**Savings**	**Actual Savings**
Federal	30.00%	of entire system expenditures (no max. limit)	$345,000	$345,000
State	$1.75/Watt	Max. limit of $87,500	$201,250	$87,500
			Total Savings	**$432,500**

Table 17: Rebates and Incentives from PV System

5.8.3 Payback Period

For an owner, one of the main concerns is the payback period for a system like this. If the owner plans on owning the building for longer that the payback period, then the owner would most likely benefit from the integration of the system into the building. If the owner does not plan on having ownership of the building for that length of time then the owner will probably end up losing money in the investment of the system. ***Appendix G*** shows the breakdown of the payback period for the 2 cost options. Option 1 considers only the additional cost of the PV system to the project if the cost of the original façade is included in the PV system and Option 2 considers the entire cost of the PV system.

The results of the payback period show two different results. If you were to look at the cost of the PV system as a whole at $1,150,000 it would take **24 years** to see a return on the investment of the PV system. If you were to just look at the additional cost to the project if you consider that you were already going to spend $546,900 on the curtain wall system anyways, there is only **a 9 year** payback period until the owner financially benefits from the PV system.

See APPENDIX G for Façade Photovoltaic System Payback Period results.

5.9 Recommendations and Conclusions

From the analysis preformed in this section, it was determined that installing a photovoltaic system on the South façade of the Global Vascular Institute would be feasible. Enough of the façade is free from shading to allow sufficient energy production to power a portion of the building. The system would be 115kW and consist of 426 panels. From the structural analysis, there would actually be a reduction in load from the original façade to the photovoltaic façade. From the electrical analysis, it is recommended that the PV system be tied-in to the current electrical system through 2 inverters located on the 8^{th} floor electrical room.

A photovoltaic system was never considered for the Global Vascular Institute due to the high cost of implementing the system into the building. From the analysis preformed, it was determined that with the use of rebates and incentives, a 9 year payback period is possible for the system. For the Global Vascular Institute, it is recommended that the PV system be implemented in the design of the project.

6.0 ELMINIATION OF INEFFICIENCY THROUGH THE USE OF FAÇADE PREFABRICATION

6.1 Problem Identification

Site congestion is a major concern facing the construction management team on this project. This issue affects all trades working on the project and has the potential to cause delays in a number of areas. The lack of space available for material storage and layout has caused the installation of the curtain wall to be a slow process. The longer it takes to enclose the building, the longer it will take to begin the interior work on the building.

6.2 Research Goal

The goal of this analysis is to perform a preliminary design of larger prefabricated façade panels compared to the current system of individual panels, and assess the impacts on the schedule, cost, and site congestion.

6.3 Methodology

- Design preliminary prefabricated panel modules for the façade of Global Vascular Institute
- Determine transportation and erection requirements for the prefabricated panels
- Analyze schedule and cost impacts of the prefabricated system
- Analyze constructability of the prefabricated system
- Analyze site congestion improvements

6.4 Background Information

The Global Vascular Institute is designed with an aluminum and glass curtain wall system as the façade of the building. This curtain wall system is made up of single aluminum and glass panels that are each installed individually. This process is very time intensive. Also because of the limited size of the site, the installation of these panels takes up a lot of space creating congestion of the site.

Prefabricated panels are known to reduce on-site labor and decrease the amount of time that is required for erection of the façade. By using larger prefabricated panels, most of the required labor time will be done at the manufacturer while the superstructure is being completed. Once the structure is finished, the panels can then be delivered to the site and installed in shorter time frame that the individual panels would have needed. This will also reduce the congestion on the site as well as eliminate delays in single panel installation.

6.5 Preliminary Panel Design

After consulting with a representative from CBO Glass, it was determined that the most logical design for the prefabricated façade would be to breakup each side of the building into prefabricated modules. Each side of the building's façade is made up of individual glass panels that are 9' x5'. Each prefabricated panel module is composed of a different arrangement Low-E glass panels. This resulted in 5 different prefabricated modules. Figures 21 - 22 shows each façade of the building and the breakdown into the prefabricated modules. Table 18 describes the features of each prefabricated module. The panels that are not included in any of the prefabricated modules are to be installed individually. After discussing with the consultant it was also decided that only the East and West facades would gain the most from prefabrication. This is because most of the North and South facades are composed of aluminum panels. The integration of these panels into the glass prefabrication panels is limited because of the seals around where the aluminum meets the glass. To maintain a proper seal, the aluminum must be installed after the glass. Because of this, only the East and West facades are analyzed for schedule savings for the Global Vascular Institute.

The sizes of the prefabricated panels were decided upon based on the size of the trucks delivering the panels and the floor to floor height of the building. A 5' width allows for the panels to lay flat on the bed of the truck. Since the floor to floor height is 18' for the Global Vascular Institute, it was decided to have two story tall panels so the height of each panel is 36". By having the panels match up at each floor level, it allows that floor to be sealed off and interior work to begin in that area.

PREFABRICATED MODULE BREAKDOWN				
East / West Elevations				
Module	Size	Quantity	Install Time (Panels/Day)	Total Time
	36' x 5'	13	3	5
	36' x 5'	37	3	13
	36' x 5'	13	3	5
	18' x 5'	30	6	5
	18' x 5'	29	6	5

Table 18: Breakdown of the 10 Prefabricated Modules

Figure 21: East Elevation Module Layout

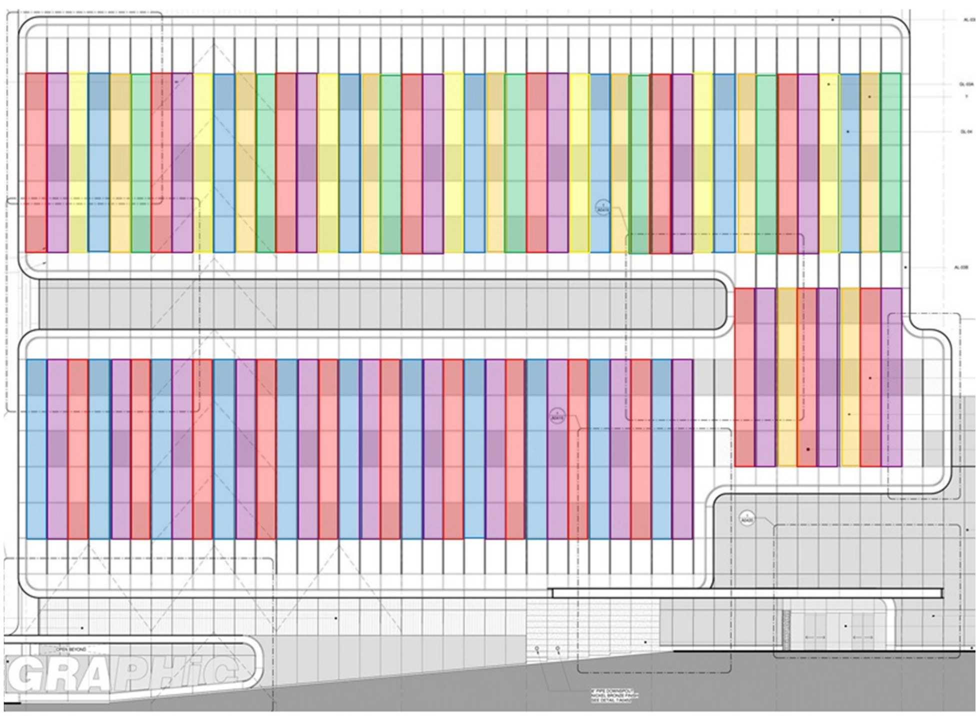


Figure 22: West Elevation Module Layout

6.6 Schedule Reduction

The goal of the prefabrication of the curtain wall was to eliminate delays from site congestion. With each of the panels being installed individually, the curtain wall was scheduled to take 204 days to complete. The erection duration for the 1020 panels in the 204 period allotted allowed 5 panels per day to be installed. The resulting schedule savings is shown in table 19. The calculation of the Prefabrication Modules represents the time required to install each of the prefabricated panels as well as the time required to install all of the individual panels.

SCHEDULE REDUCTION BREAKDOWN DUE TO PREFABRICATED MODULES						
Elevation	**Façade SF**	**# of Individual Panels**	**Individual Panels/Day**	**Individual Panel Duration (Days)**	**Prefabricated Module Duration (Days)**	**Schedule Savings (Days)**
East	35,721	440	5	88	49	(39)
West	35,721	580	5	116	64	(52)
Total	**71,442**	**1020**	**5**	**204**	**113**	**(91)**

Table 19: Schedule Reduction Breakdown due to Prefabricated Modules

With the use of prefabricated panels on the East and West facades of the Global Vascular Institute, a total savings of 91 days is obtained. This is just under a 50% savings in installation time. This though does not take into account the time required to construct the prefabricated panels off site in the fabrication shop. The time required for fabrication though can be done while the steel is being erected.

6.7 System Cost

By using prefabrication for the construction of the East and West facades, an additional cost will be endured by to the extra planning and shop time required for construction. Through discussion with a representative from CBO Glass, it was estimated that it cost an additional $5/SF to prefabricate the façade of the building. Table 20 shows the additional cost this would bring to the project. This cost only accounts for the shop time required for the construction of the prefabricated panels. The material cost would remain the same for both stick-built and prefabricated panels.

COST OF PREFABRICATED FACADE			
Square Footage of Façade	**Cost/SF**	**Total Cost to Project**	**% of Overall Cost**
71,442	$5/SF	**$357,210**	.12%

Table 20: Breakdown of the Cost of a Prefabricated Façade

6.8 Site Congestion Reduction

One of the main reasons for using prefabrication for the façade was to reduce the amount of congestion on-site. Since the Global Vascular Institute site is so small, it is important that as much site congestion as possible be eliminated. As determined in the schedule reduction section, the time required to install the prefabricated panels greatly decreases the time required to install the façade. This will allow for the façade installation to be completed earlier and will then not have to interfere with as much interior and finishes work going on. By prefabricating the façade the amount of materials on site will also greatly decrease. Since the panels will arrive on-site ready to be placed, fewer materials have the chance to be misplaced or take up excessive space. These prefabricated panels can be taken directly from the truck and installed. No storage on-site will be required.

6.9 Recommendations and Conclusion

From the analysis performed in this section, it was determined that the use of prefabrication for installation of the façade is feasible. The goal of this analysis was to reduce the schedule for the installation of the façade and to reduce site congestion. From consultation with a representative from CBO Glass, only the East and West façades were analyzed for the benefits of using prefabrication.

By utilizing prefabrication in the façade, a total of 91 days was saved on the schedule. The use of prefabrication though does increase the cost of the project by $357,210 but in relation to the overall cost of the project, this is very minimal. By using prefabrication, it was also determined that the site congestion is greatly reduced on-site. Each of the prefabricated panels will be brought on-site, ready to install and require no storage space. This will just require extra planning so that the trucks arrive exactly when installation of each panel is to occur. For the Global Vascular Institute, it is recommended that prefabrication of the façade be implemented into the project.

7.0 LEED CERTIFICATION

7.1 Problem Identification

The Global Vascular Institute project is not pursuing LEED Certification once it is completed. Due to budgetary issues, becoming LEED Certified did not seem plausible or beneficial. Although initially a study was not done to determine if LEED should be pursued, becoming LEED Certified could have multiple advantages to the project, including energy savings, cost savings, as well as the prestige of being certified by LEED.

7.2 Research Goal

The goal of this analysis is to perform an in-depth study into the criteria required for the Global Vascular Institute to become at least LEED certified. In-depth research will be focused on the categories of Energy and Atmosphere and Materials and Resources.

7.3 Methodology

- Research LEED certification and the points required to achieve LEED certification
- Analyze the Global Vascular Institute for LEED points already included in the design
- Determine which LEED points are most financially beneficial for Global Vascular Institute pursue
- Determine the cost to implement LEED points not already included in the current design
- Analyze lifecycle costs of implementing new LEED ideas into the building and ensure that each idea is able to be constructed
- Determine potential payback period of implementing new LEED ideas

7.4 Background Information

For many owners, the main issue for whether or not to pursue being a LEED rated building is based on how much it will cost. For the Global Vascular Institute, this was the main reason that a LEED rating was not pursed at all. Although, the additional costs can be quite high when constructing a LEED rated building, being classified as a LEED building can also have many benefits. By being LEED rated, it shows that this building is in fact sustainable and gives off a persona of being a "healthy" building. Since the function of the Global Vascular Institute is to be a high-tech medical research and hospital, by having your building rated as sustainable or "healthy" can support the healthy work being done inside the building as well.

7.5 LEED Points Analysis

7.5.1 Soft Costs

To evaluate the cost to make the Global Vascular Institute reach different LEED certifications, the soft costs associated with attempting to construct a LEED building must first be examined. These soft costs are any costs that are not directly involved in the physical construction of the building. These costs include extra design costs from the architect, documentation and application fees for all LEED related paperwork, and energy modeling costs. Table 21 shows the soft costs estimated for the Global Vascular Institute. These percentages were obtained from the article, "Analyzing the Cost of Obtaining LEED Certification" and are just estimates of the soft costs of the building. They are not exact values.

SOFT COSTS ESTIMATE			
Cost Description	**% of Construction Cost**	**Total Construction Cost**	**Cost to Project**
Design Costs	.5	$291,000,000	$1,455,000
Documentation & Application Fees	.5	$291,000,000	$1,455,000
Energy Modeling	.1	$291,000,000	$291,000
		Total	**$3,201,000**

Table 21: Soft Costs Estimate Breakdown

7.5.2 Hard Costs

The hard costs associated with having the Global Vascular Institute being LEED rated apply to all of the costs towards physically constructing the building. To analyze these costs, a point by point analysis of the LEED rating system as it applies to the Global Vascular Institute is arranged as follows.

- LEED Section – Credit Description (# of Obtainable Points)
- Intent
- Requirements
- Potential Strategies
- Analysis within the Global Vascular Institute
- Cost Summary
- Additional Thoughts

The following information for each LEED credit was obtained from the *LEED 2009 for New Construction and Major Renovations* rating manual.

Sustainable Sites Prerequisite 1: Construction Activity Pollution Prevention (Required)

Intent

To reduce pollution from construction activities by controlling soil erosion, waterway and airborne dust generation.

Requirements

Create and implement an erosion and sediment control plan for all construction activities associated with the project. The plan must conform to the erosion and sedimentation requirements of the 2003 EPA Construction Genera Permit OR local standards and codes, whichever is more stringent. The plan must describe the measures implemented to accomplish the following objectives:

- To prevent loss of soil during construction by storm water runoff and/or wind erosion, including protecting topsoil by stockpiling for reuse.
- To prevent sedimentation of storm sewers or receiving streams.
- To prevent pollution of the air with dust and particular matter.

Potential Strategies

Create an erosion and sedimentation control plan during the design phase of the project. Consider employing strategies such as temporary and permanent seeding, mulching, earthen dikes, silt fencing, sediment traps and sediment basins.

Analysis within the Global Vascular Institute

No cost analysis was performed for this prerequisite because the erosion and sedimentation plan is already included in the Global Vascular Institute project.

Cost Summary

No additional cost to the project

Additional Thoughts

See Appendix H for the Global Vascular Institute's grading plan which includes erosion and sedimentation control notes.

Sustainable Sites Credit 1: Site Selection (1 Point)

Intent
To avoid the development of inappropriate sites and reduce the environmental impact from the location of a building on a site.

Requirements
Do not develop buildings, hardscape, roads, or parking areas on portions of sites that meet any of the following criteria:

- Prime farmland as defined by the U.S. Department of Agriculture in the United States Code of Federal Regulations, Title 7, Volume 6, Parts 400 to 699, Section 657.5 (citation 7CFR657.5)
- Previously undeveloped land whose elevation is lower than 5 feet above the elevation of the 100-year flood as defined by the Federal Emergency Management Agency (FEMA)
- Land specifically identified as habitat for any species on federal or state threatened or endangered lists
- Land within 100 feet of any wetlands as defined by the U.S. Code of Federal Regulations 40 CFR, Parts 230-233 and Part 22, and isolated wetlands or areas of special concern identified by state of local rule, OR within setback distances from the wetlands prescribed in state of local regulations, as defined by local or state rule or law whichever is more stringent.
- Previously undeveloped land that is within 50 feet of a water body, defined as seas, lakes, rivers, streams and tributaries that support or support fish, recreation or industrial use, consistent with the terminology of the Clean Water Act
- Land that prior to acquisition for the project was public parkland, unless land of equal or greater value as parkland is accepted in trade by the public landowner (park authority projects are exempt)

Potential Strategies
During the site selection process, give preference to sites that do not include sensitive elements or restrictive land types. Select a suitable building location and design the building with a minimal footprint to minimize disruption of the environmentally sensitive areas identified above.

Analysis within the Global Vascular Institute
Credit 1 is achieved by that it is not on site that falls into any of the above location types.

Cost Summary
No additional cost to the project is sustained because the site was selected from the project start.

Additional Thoughts
None

Sustainable Sites Credit 2: Development Density and Community Connectivity (5 Points)

Intent
To channel development to urban areas with existing infrastructure, protect greenfields, and preserve habitat and natural resources.

Requirements
Option 1: Development Density

Construct or renovate a building on a previously developed site AND in a community with a minimum density of 60,000 square feet per acre net. The density calculation is based on a typical two-story downtown development and must include the area of the project being built.

OR

Option 2: Community Connectivity

Construct or renovate a building on a site that meets the following criteria:

- Is located on a previously developed site
- Is within ½ mile of a residential area or neighborhood with and average density of 10 units per acre net
- Is within ½ mile of at least 10 basic services
- Has pedestrian access between the building and the services

Potential Strategies
During the site selection process, give preference to urban sites with pedestrian access to a variety of services.

Analysis within the Global Vascular Institute
Credit 2 is achieved by meeting the criteria of Option 2.

Cost Summary
No additional cost to the project is sustained since the site is located in an area that meets all of the above criteria.

Additional Thoughts
None

Sustainable Site Credit 3: Brownfield Redevelopment (1 Point)

Intent
To rehabilitate damaged sites where development is complicated by environment contamination and to reduce pressure on undeveloped land.

Requirements
Option 1

Develop on a site documented as contaminated (by means of an ASTM E1903-97 Phase II Environmental Site Assessment or a local voluntary cleanup program).

OR

Option 2

Develop on a site defined as a brownfield by a local, state, or federal government agency.

Potential Strategies
During the site selection process, give preference to brownfield sites. Identify tax incentives and property cost savings. Coordinate site development plans with remediation activity, as appropriate.

Analysis within the Global Vascular Institute
The Global Vascular Institute is not located on a contaminated or brownfield site so Sustainable Site Credit 3 is no obtainable.

Cost Summary
No additional cost to the project because the credit is not obtainable.

Additional Thoughts
None

Sustainable Site Credit 4.1: Alternative Transportation–Public Transportation Access (6 Points)

Intent
To reduce pollution and land development impacts form automobile use.

Requirements
Option 1: Rail Station Proximity

Locate project within ½-mile walking distance (measured from a main building entrance) of an existing or planned and funded commuter rail, light rail or subway station.

OR

Option 2: Bus Stop Proximity

Locate the project within ¼-mile walking distance (measured from a main building entrance) or 1 or more stops for 2 or more public, campus, or private bus lines usable by building occupants.

Potential Strategies
Preform a transportation survey of future building occupants to identify transportation needs. Locate the building near mass transit.

Analysis within the Global Vascular Institute
Sustainable Site Credit 4.1 is achieved by 2 existing bus stops and routes located within ¼-mile to the entrance of the Global Vascular Institute.

Cost Summary
No additional cost to the project is sustained because there are already existing bus stops within the ¼-mile walking distance to the Global Vascular Institute.

Additional Thoughts
None

Sustainable Site Credit 4.2: **Alternative Transportation–Bicycle Storage and Changing Rooms (1 Point)**

Intent
To reduce pollution and land development impacts from automobile use.

Requirements
Case 1: Commercial or Institutional Projects

Provide secure bicycle racks and/or storage within 200 yards of a building entrance for 5% or more of all building users (measured at peak periods).

Provide shower and changing facilities in the building, or within 200 yards of a building entrance, for 0.5% of full-time equivalent (FTE) occupants.

Case 2: Residential Projects

Provide covered storage facilities for securing bicycles for 15% or more of building occupants.

Potential Strategies
Design the building with transportation amenities such as bicycle racks and shower/changing facilities.

Analysis within the Global Vascular Institute
Sustainable Sites Credit 4.2 is achieved because bike racks and changing rooms/showers are in the original design of the Global Vascular Institute in accordance to the credits requirements.

Cost Summary
No additional cost to the project is sustained because the requirements for the credit are met in the original design of the Global Vascular Institute.

Additional Thoughts
None

Sustainable Sites Credit 4.3: **Alternative Transportation-Low-Emitting and Fuel-Efficient Vehicles**

Intent

To reduce pollution and land development impacts from automobile use.

Requirements

Option 1

Provide preferred parking for low-emitting and fuel-efficient vehicles for 5% of the total vehicle parking capacity of the site. Providing a discounted parking rate is an acceptable substitute for preferred parking for low-emitting/fuel-efficient vehicles. To establish a meaningful incentive in all potential markets, the parking rate must be discounted at least 20%. The discounted rate must be available to all customers (i.e., not limited to the number of customers equal to 5% of the vehicle parking capacity), publicly posted at the entrance of the parking area and available for a minimum of 2 years.

OR

Option 2

Install alternative-fuel fueling stations for 3% of the total vehicle parking capacity of the site. Liquid or gaseous fueling facilities must be separately ventilated or located outdoors.

OR

Option 3

Provide low-emitting and fuel-efficient vehicles for 3% of full-time equivalent (FTE) occupants. Provide preferred parking for these vehicles.

OR

Option 4

Provide Building occupants access to a low-emitting or fuel efficient vehicle-sharing program. The following requirements must be met:

- One low-emitting or fuel-efficient vehicle must be provided per 3% of FTE occupants, assuming that 1 shard vehicle can carry 8 persons (i.e., 1 vehicle per 267 FTE occupants). For buildings with fewer than 267 FTE occupants, at least 1 low emitting or fuel-efficient vehicle must be provided.
- A vehicle-sharing contract must be provided that has an agreement of at least 2 years.
- The estimated number of customers served per vehicle must be supported by documentation.
- A narrative explaining the vehicle-sharing program and its administration must be submitted.
- Parking for low-emitting and fuel-efficient vehicles must be located in the nearest available spaces in the nearest available parking area. Provide a site plan or area map clearly highlighting the walking path from the parking area to the project site and noting the distance.

Potential Strategies

Provide transportation amenities such as alternative-fuel refueling stations. Consider sharing the costs and benefits of refueling stations with neighbors.

Analysis within the Global Vascular Institute

For the Global Vascular Institute options 2, 3, and 4 would be a very high cost to the building since it is a 24-hour facility with a large number of full-time employees. Option 1 is the best choice for the Global Vascular Institute to pursue sustainable sites credit 4.3. Providing 5% of the total parking capacity for preferred parking requires that only 1 space be preferred. This is because of the very few number of on-site parking spaces located on the site. There is a parking garage across from the site that many of the occupants of the building will use as well. With this parking garage already constructed making specific spots preferred parking will be a minimal to no cost.

Cost Summary

No additional cost to the project is sustained because the preferred parking spaces on the site would already be designated in the original design of the building.

Additional Thoughts

None

Sustainable Site Credit 4.4: Alternative Transportation – Parking Capacity (2 Points)

Intent
To reduce pollution and land development impacts from automobile use.

Requirements
Case 1: Non-Residential Projects

Option 1

Size parking capacity to meet but not exceed minimum local zoning requirements. Provide preferred parking for carpools or vanpools for 5% of the total parking spaces.

OR

Option 2

For projects that provide parking for less than 5% of full-time equivalent (FTE) building occupants: Provide preferred parking for carpools or vanpools, marked as such, for 5% of total parking spaces. Providing a discounted parking rate is an acceptable substitute for preferred parking for carpool or vanpool vehicles. To establish a meaningful incentive in all potential markets, the parking rate must be discounted at least 20%. The discounted rate must be available to all customers (i.e., not limited to the number of customers equal to 5% of the vehicle parking capacity), publicly posted at the entrance of the parking area, and available for a minimum of 2 years.

OR

Option 3

Provide no new parking.

Potential Strategies
Minimize parking lot/garage size. Consider sharing parking facilities with adjacent buildings. Consider alternatives that will limit the use of single occupancy vehicles.

Analysis within the Global Vascular Institute
The sustainable site credit 4.4 can be obtained for the Global Vascular Institute by following the requirements of option 2. The total number of new parking spaces being designed for the Global Vascular Institute is 7. This number is extremely low for a facility of this type but the existing parking garage across the street will be the main parking for this building. These new parking spaces will provide much less than 5% of the spaces required by full-time equivalent occupants. So from these 7 new parking spaces, only 1 space needs to be designated for preferred parking spaces for carpool or vanpool vehicles.

Cost Summary
No additional cost to the project is sustained because the preferred parking spaces on the site would already be designated in the original design of the building.

Additional Thoughts
None

Sustainable Sites Credit 5.1: Site Development - Protect or Restore Habitat (1 Point)

Intent
To conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity.

Requirements
Case 1: Greenfield Sites
Limit all site disturbances to the following parameters:

- 40 feet beyond the building perimeter;
- 10 feet beyond surface walkways, patios, surface and utilities less than 12 inches in diameter;
- 15 feet beyond primary roadway curbs and main utility branch trenches;
- 25 feet beyond constructed areas with permeable surfaces (such as pervious paving areas, storm water detention facilities and playing fields) that requires additional staging areas to limit compaction in the constructed area.

Case 2: Previously Developed Areas or Graded Sites
Restore or protect a minimum of 50% of the site (excluding the building footprint) or 20% of the total site area (including building footprint), whichever is greater, with native or adapted vegetation. Projects earning Sustainable Sites Credit 2: Development Density and Community Connectivity may include vegetated roof surface in this calculation if the plants are native or adapted, provide habitat, and promote biodiversity.

Potential Strategies
Survey greenfield sites to identify site elements and adopt a master plan for developing the project site. Carefully site the building to minimize disruption to existing ecosystems and design the building to minimize its footprint. Strategies include stacking the building program, tuck-under parking and sharing parking facilities with neighbors. Establish clearly-marked construction boundaries to minimize disturbance of the existing site and restore previously degraded areas to their natural state. For previously developed sites, use local and regional governmental agencies, consultants, educational facilities and native plant societies as resources for the selection of appropriate native or adapted plants. Prohibit plants listed as invasive or noxious weed species. Once established, native/adapted plants required minimal or no irrigation; do not require maintenance such as mowing or chemical inputs such as fertilizers, pesticides or herbicides; and provide habitat value and promote biodiversity through avoidance of monoculture plantings.

Analysis within the Global Vascular Institute
The sustainable sites credit 5.1 is obtainable by following the criteria of case 2 since this is a previously developed site. The area of the entire site is about 16,791SF. To meet the criteria of

this credit, 20% of this area, or 16,791SF of space must be restored with native or adapted vegetation. With the planting of the landscaping and the green roof space, about 17,000SF of space is covered by vegetation, which meets the credits requirements.

Cost Summary

No additional cost to the project is sustained because the required vegetation space is accounted for in the original design.

Additional Thoughts

None

Sustainable Sites Credit 5.2: Site Development – Maximize Open Space (1 Point)

Intent
To promote biodiversity by providing a high ratio of open space to development footprint.

Requirements
Case 1: Sites with Local Zoning Open Space Requirements

Reduce the development footprint and/or provide vegetated open space within the project boundary such that the amount of open space exceeds local zoning requirements by 25%.

Case 2: Sites with no Local Zoning Requirements (e.g. some university campuses, military bases)

Provide a vegetated open space area adjacent to the building that is equal in area to the building footprint.

Case 3: Sites with Zoning Ordinances but No Open Space Requirements

Provide vegetated open space equal to 20% of the project site area.

All Cases

For projects in urban areas that earn Sustainable Sites Credit 2: Development Density and Community Connectivity, vegetated roof areas can contribute to credit compliance.

For projects in urban areas that earn Sustainable Sites Credit 2: Development Diversity and Community Connectivity, pedestrian-oriented hardscape areas can contribute to credit compliance. For such projects, a minimum of 25% of the open space counted must be vegetated.

Wetlands or naturally designed ponds may count as open space and the side slope gradients average 1:4 (vertical: horizontal) or less and are vegetated.

Potential Strategies
Perform a site survey to identify site elements and adopt a master plan for developing the project site. Select a suitable building location and design the building footprint to minimize site disruption. Strategies include stacking the building program, tuck-under parking and sharing parking facilities with neighbors to maximize the amount of open space on the site.

Analysis within the Global Vascular Institute
The sustainable sites credit 5.2 is obtainable by meeting the requirements of case 3. The local zoning ordinances for the Global Vascular Institute do not have any open space requirements. As stated in the sustainable sites credit 5.1, over 20% of the total project site is covered by vegetation.

Cost Summary
No additional cost to the project is sustained because the required open/vegetation space is accounted for in the original design.

Additional Thoughts
None

Sustainable Sites Credit 6.1: Stormwater Design – Quantity Control (1 Point)

Intent

To limit disruption of natural hydrology by reducing impervious cover, increasing on-site infiltration, reducing or eliminating pollution from Stormwater runoff and eliminating contaminants.

Requirements

Case 1: Sites with Existing Imperiousness 50% or Less

Option 1

Implement a Stormwater management plan that prevents the post-development peak discharge rate and quantity from exceeding the predevelopment peak discharge rate and quantity for the 1-and 2-year 24-hour design storms.

OR

Option 2

Implement a Stormwater management plan that protects receiving stream channels from excessive erosion. The Stormwater management plan must include stream channel protection quantity control strategies.

Case 2: Sites with Existing Impervious Greater Than 50%

Implement a Stormwater management plan that results in a 25% decrease in the volume of Stormwater runoff from the 2-year 24 hour design storm.

Potential Strategies

Design the project site to maintain natural Stormwater flows by promoting infiltration. Specify vegetated roofs, pervious paving and other measures to minimize impervious surfaces. Reuse Stormwater for non-potable uses such as landscape irrigation, toilet and urinal flushing, and custodial uses.

Analysis within the Global Vascular Institute

The Global Vascular Institute was designed with a grading and drainage plan for stormwater. To obtain this sustainable sites credit 6.1, it will be assumed that the grading and drainage plan was designed to keep the discharge rate the same as the pre-developed land or it was designed to reduce the discharge rate.

Cost Summary

No additional cost for the project is sustained because the grading and drainage plan is a part of the buildings original design.

Additional Thoughts

***See Appendix H for the Global Vascular Institute's grading plan*.**

Sustainable Sites Credit 6.2: Stormwater Design – Quality Control (1 Point)

Intent
To limit disruption and pollution of natural water flows by managing stormwater runoff.

Requirements
Implement a stormwater management plan that reduces impervious cover, promotes infiltration and captures and treats the stormwater runoff from 90% of the average annual rainfall using acceptable best management practices (BMPs).

BMPs used to treat runoff must be capable of removing 80% of the average annual post-development total suspended solids (TSS) load based on existing monitoring reports. BMPs are considered to meet these criteria if:

- They are designed in accordance with standards and specifications from a state or local program that has adopted these performance standards,

OR

- There exists infield performance monitoring data demonstrating compliance with criteria. Data must conform to accepted protocol (e.g., Technology Acceptance Reciprocity Partnership [TARP], Washington State Department of Ecology) for BMP monitoring.

Potential Strategies
Use alternative surfaces (e.g., vegetated roofs, pervious pavements, grid pavers) and nonstructural techniques (e.g., rain gardens, vegetated swales, disconnection of imperviousness, rainwater recycling) to reduce imperviousness and promote infiltration and thereby reduce pollutant loadings.

Use sustainable design strategies (e.g., low-impact development, environmentally sensitive design) to create integrated natural and mechanical treatment systems such as constructed wetlands, vegetated filters and open channels to treat stormwater runoff.

Analysis within the Global Vascular Institute
To achieve sustainable sits credit 6.2 for the Global Vascular Institute, 90% of the average annual rainfall on the site must be captured and treated. The best way to do this would be to either have a rainwater collection and treatment plant or have a vegetative roof. To obtain 90% of the rainwater though, it would also be necessary to include the treatment of stormwater from all pavement runoffs as well.

Cost Summary
To determine the cost of obtaining sustainable sites credit 6.2, the cost of a vegetative roof and pervious pavement were calculated. Table 22 shows the breakdown of cost/SF for both the vegetative roof and pervious pavement. The costs/SF were determined through product data obtained from different manufacturers.

STORMWATER MANAGEMENT ESTIMATE			
Pervious Pavement Estimate			
Pavement Type	**Square Feet**	**Cost/SF**	**Cost**
Existing	48,000	$2.25	$108,000
Pervious	48,000	$2.11	$101,280
		Cost Difference	($6,720)
Vegetative Roofing Estimate			
Roof Type	**Square Feet**	**Cost/SF**	**Cost**
Live Roof (Original Design)	5954	-	-
Live Roof	29,768	$15.00	$446,520
		Total Cost	**$439,800**

Table 22: Stormwater Management Estimate Breakdown

As shown in table 22 there is an increased cost in installing a vegetative roof to the rest of the Global Vascular Institute. There is however a savings in cost by changing the existing pavement to pervious pavement on the site. With the pervious pavement though it is important to note it will require quarterly maintenance which includes vacuuming and power washing to make sure that it is functioning properly. These costs are not including in the pervious pavement estimate.

Additional Thoughts

By achieving the sustainable sites credit 6.2, other sustainable sites credits have the possibility to be achieved as well. These credits include Sustainable Sites credit 7.1: Heat Island Effect (Non-roof) and Sustainable Sites Credit 7.2: Heat Island Effect (Roof). This is due to the use of a fully vegetative roof system and a complete pervious pavement system on the site.

Sustainable Sites Credit 7.1: Heat Island Effect – Non-roof (1 Point)

Intent
To reduce heat islands to minimize impacts on microclimates and human and wildlife habitats.

Requirements
Option 1

Use any combination of the following strategies for 50% of the site hardscape (including roads, sidewalks, courtyards and parking lots):

- Provide shade from the existing tree canopy or within 5 years of landscape installation. Landscaping (trees) must be in place at the time of occupancy.
- Provide shade from structures covered by solar panels that produce energy used to offset some nonrenewable resource use.
- Provide shade from architectural devices or structures that have a solar reflectance index (SRI) of at least 29.
- Use hardscape materials with an SRI of at least 29.
- Use an open-grid pavement system (at least 50% pervious).

OR

Option 2

Place a minimum of 50% of parking spaces under cover. Any roof used to shade or cover parking must have an SRI at least 29, be a vegetated green roof or be covered by solar panels that produce energy used to offset some nonrenewable use.

Potential Strategies
Employ strategies, materials and landscaping techniques that reduce the heat absorption of exterior materials. Use shade (calculated on June 21, noon solar time) form native or adapted trees and large shrubs, vegetated trellises or other exterior structures supporting vegetation. Consider using new coating and integral colorants for asphalt to achieve light-colored surfaces instead of blacktop. Position photovoltaic cells to shade impervious surfaces. Consider replacing constructed surfaces (e.g., roof, roads, sidewalks, etc.) with vegetated surfaces such as vegetated roofs and open grid paving or specify high-albedo materials, such as concrete, to reduce heat absorption.

Analysis within the Global Vascular Institute
On the Global Vascular Institute site, there is about 48,000 SF of hardscape area. Due to the nature of the facility and closeness of the parking areas to the building, having underground or covered parking areas is difficult and inappropriate to accommodate to the Global Vascular Institute.

If the owner of the building decides to obtain Sustainable Sites Credit 6.2: Stormwater Design (Quality Control), then the cost of achieving Sustainable Sites Credit 7.1: Heat Island Effect (Non-roof) will already be included in the cost of SS. Credit 6.2.

If the owner of the building decides to only attempt to obtain Sustainable Sites Credit 7.1, then the site has to have at least 50% of the hardscape as either pervious pavement or a SRI of 29 or higher.

Cost Summary
Table 23 below shows the breakdown of the cost estimates for 50% of the hardscape of the Global Vascular Institute being changed to either pervious pavement or to slate pavement with an SRI of 34. The costs/SF were determined through product data obtained from different manufacturers.

HEAT ISLAND EFFECT PAVEMENT ESTIMATE			
Pervious Pavement Estimate			
Pavement Type	**Square Feet**	**Cost/SF**	**Cost**
Existing	24,000	$2.25	$54,000
Pervious	24,000	$2.11	$50,640
		Cost Difference	($3,360)
Slate Pavement Estimate			
Type	**Square Feet**	**Cost/SF**	**Cost**
Streetbond SR Slate (SRI=34)	24,000	$2.15	$51,600

Table 23: Heat Island Effect Pavement Estimate Breakdown

Table 24 below shows how much each of the options for obtaining Sustainable Sites Credit 7.1 will cost. With the pervious pavement though it is important to note it will require quarterly maintenance which includes vacuuming and power washing to make sure that it is functioning properly. These costs are not including in the pervious pavement estimate.

TOTAL COST OF PAVEMENT CHOICE	
Description	**Total Cost**
S.S. Credit 6.2	$0.00
S.S. Credit 7.1 – Pervious Pavement to 50% of hardscape	($3,360)
S.S. Credit 7.1 – Streetbond SR Slate (SRI=34) to 50% of hardscape	$51,600

Table 24: Cost of different pavement choices for obtaining S.S. Credit 7.1

Additional Thoughts
See Appendix I for the product data for the Streetbond SR slate.

Sustainable Sites Credit 7.2: Heat Island Effect – Roof (1 Point)

Intent

To reduce heat islands to minimize impacts on microclimates and human and wildlife habitats.

Requirements

Option 1

Use roofing materials with a solar reflectance index (SRI) equal to or greater that the values in the table below for a minimum of 75% of the roof surface.

Roofing materials having a lower SRI value than those listed below may be used if the weighted rooftop SRI average meets the following criteria:

$$\frac{\text{Area Roof Meeting Minimum SRI}}{\text{Total Roof Area}} \times \frac{\text{SRI of Installed Roof}}{\text{Required SRI}} \geq 75\%$$

Roof Type	Slope	SRI
Low-sloped roof	≤ 2:12	78
Steep-sloped roof	> 2:12	29

OR

Option 2

Install a vegetated roof that covers at least 50% of the roof area.

OR

Option 3

Install high-albedo and vegetated roof surfaces that, in combination, meet the following criteria:

$$\frac{\text{Area Roof Meeting Minimum SRI}}{0.75} + \frac{\text{Area of Vegetated Roof}}{0.5} \geq \text{Total Roof Area}$$

Roof Type	Slope	SRI
Low-sloped roof	≤ 2:12	78
Steep-sloped roof	> 2:12	29

Potential Strategies

Consider installing high-albedo and vegetated roofs to reduce heat absorption. Default values will be available in the LEED Reference Guide for Green Building Design and Construction, 2009 Edition. Production information is available from the Cool Roof Rating Council website at http://www.coolroofs.org/ and the ENERGY STAR website at http://www.energystar.gov/.

Analysis within the Global Vascular Institute

If the owner of the building decides to obtain Sustainable Sites Credit 6.2: Stormwater Design (Quality Control), then the cost of achieving Sustainable Sites Credit 7.1: Heat Island Effect (Non-roof) will already be included in the cost of SS. Credit 6.2.

If the owner of the building decides to only attempt to obtain Sustainable Sites Credit 7.2, then either the roof must be 75% covered with reflective roofing membrane or 50% covered with vegetated roof area.

Cost Summary

Table 25 below shows the breakdown of the cost estimates for 75% of the roofing area of the Global Vascular Institute being changed to reflective roofing membrane and changing 50% of the roofing area to vegetative roofing. The costs/SF were determined through product data obtained from different manufacturers. The cost/SF for the reflective roofing membrane is the difference in cost between the existing roofing and the Cerama Flex roofing.

HEAT ISLAND EFFECT ROOF ESTIMATE			
75% Reflective Roofing Membrane			
Roof Type	**Square Feet**	**Cost/SF**	**Cost**
Cerama Flex Grey, Field Applied Coating Roofing System (SRI=103)	26,791	$2.00	$53,582
50% Vegetative Roofing Estimate			
Roof Type	**Square Feet**	**Cost/SF**	**Cost**
Live Roof (Original Design)	5954	-	-
Live Roof	11,907	$15.00	$178,605

Table 25: Heat Island Effect Roofing Estimate Breakdown

Table 26 below shows how much each of the options for obtaining Sustainable Sites Credit 7.2 will cost.

TOTAL COST OF ROOFING CHOICE	
Description	**Total Cost**
S.S. Credit 6.2	$0.00
S.S. Credit 7.2 – 75% Reflective Roofing Membrane	$53,582
S.S. Credit 7.2 – 50% Vegetative Roofing	$178,605

Table 26: Cost of Difference Roofing Options for Obtaining Sustainable Sites Credit 7.2

Additional Thoughts

None

Sustainable Sites Credit 8: Light Pollution Reduction (1 Point)

Intent

To minimize light trespass from the building and site, reduce sky-glow to increase night sky access, improve nighttime visibility through glare reduction and reduce development impact form lighting on nocturnal environments.

Requirements

Project teams must comply with 1 of the 2 options for interior lighting AND the requirement for exterior lighting.

For Interior Lighting

Option 1

Reduce the input power (by automatic device) of all nonemergency interior luminaires with a direct line of sight to any openings in the envelope (translucent or transparent) by at least 50% between 11 p.m. and 5 a.m. After-hours override may be provided by a manual or occupant-sensing device provided the override lasts no more than 30 minutes.

OR

Option 2

All openings in the envelope (translucent or transparent) with direct line of sight to any nonemergency luminaries must have shielding (controlled/closed by automatic device for a resultant transmittance of less than 10% between 11 p.m. and 5 a.m.).

For Exterior Lighting

Light areas only as required for safety and comfort. Lighting power densities must not exceed ANSI/ASHRAE/IESNA Standard 90.1-2007 (with errata but without addenda) for the classified zone. Meet exterior lighting control requirements from ANSI/ASHRAE/IESNA Standard 90.1-2007 (with errata but without addenda) Exterior Lighting Section, without amendments. Classify the project under 1 of the following zones, as defined in IESNA RP-33, and follow all the requirements for that zone:

LZ3: Medium (all other areas not included in LZ1, LZ2, or LZ4, such as commercial/industrial, and high-density residential)

Design exterior lighting so that all site and building-mounted luminaires produce a maximum initial illuminance value no greater than 0.20 horizontal and vertical foot-candles at the site boundary and no greater than 0.01 horizontal foot-candles 15 feet beyond the site. Document that no more than 5% of the total initial designed fixture lumens (sum total of all fixtures on site) are emitted at an angle of 90 degrees or higher from nadir (straight down).

LZ2, LZ3, and LZ4 – For site boundaries that abut public rights-of-way, light trespass requirements may be met relative to the curb line instead of the site boundary/

For All Zones – Illuminance generated from a single luminaire placed at the intersection of a private vehicular driveway and public roadway accessing the site is allowed to use the centerline of the public roadway as the site boundary for a length of 2 times the driveway width centered at the centerline of the driveway.

Potential Strategies
Adopt site lighting criteria to maintain safe levels while avoiding off-site lighting and night sky pollution. Minimize site lighting where possible, and use computer software to model the site lighting, Technologies to reduce light pollution include full cutoff luminaries, low-reflectance and low-angle spotlights.

Analysis within the Global Vascular Institute
For the Global Vascular Institute, the sustainable site credit 7.2 is unobtainable because of the interior lighting requirements. Since this building is a hospital and medical research facility and is open 24-hours per day, automatic interior lighting controls that reduce the input of power during certain times at night cannot be applied into this building. Each patient in the hospital as well as every researcher may have different needs for different times of the night and day so it is important to have the lighting power available whenever it is needed.

Cost Summary
No additional cost to the project is sustained because the sustainable sites credit 7.2 is unobtainable.

Additional Thoughts
None

Water Efficiency Prerequisite 1: Water Use Reduction (Required)

Intent
To increase water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.

Requirements
Employ Strategies that in aggregate use 20% less water than the water use baseline calculated for the building (not including irrigation).

Calculate the baseline according to the commercial and/or residential baselines outlines below. Calculations are based on estimated occupant usage and must include only the following fixtures and fixture fittings (as applicable to the project scope): water closets, urinals, lavatory faucets, showers, kitchen sink faucets and pre-rinse spray valves.

Commercial Fixtures, Fittings, and Appliances	Current Baseline
Commercial toilets	1.6 gallons per flush (gpf)* Except blow-out fixtures: 3.5 (gpf)
Commercial urinals	1.0 (gpf)
Commercial lavatory (restroom) faucets	2.2 gallons per minute (gpm) at 60 pounds per square inch (psi), private applications only (hotel or motel guest rooms, hospital patient rooms) 0.5 (gpm) at 60 (psi)** all others except private applications 0.25 gallons per cycle for metering faucets
Commercial prerinse spray valves (for food service applications)	Flow rate ≤ 1.6 (gpm) (no pressure specified; no performance requirement)

The following fixtures, fittings and applications are outside the scope of the water use reduction calculation:

- Commercial steam Cookers
- Commercial Dishwashers
- Automatic Commercial Ice Makers
- Commercial (family sized) Clothes Washers

Potential Strategies
WaterSense-certified fixtures and fixture fittings should be used where available. Use high-efficiency fixtures (e.g., water closets and urinals) and dry fixtures, such as toilets attached to composting systems, to reduce potable water demand. Consider using alternative on-site sources of water (e.g., rainwater, stormwater, and air conditioner condensate) and graywater for non-potable applications such as custodial uses and toilet and urinal flushing. The quality of any alternative source of water used must be taken into consideration based on its application or use.

Analysis within the Global Vascular Institute
To calculate the water reduction necessary to obtain this credit, the baseline quantities, the current quantities and high-efficiency quantities from the water fixtures for the Global Vascular

Institute were compared; which is shown in table 27. Since there are very few urinals located within the building since most of the restrooms are same sex single facilities, it was assumed that the number of uses for each water closet per day is the same. It is also important to note the difference between the private and public faucets throughout the building. The private faucets account only for all of the faucets used in patient's rooms.

WATER REDUCTION SAVINGS/GALLON									
Fixture	**Quantity**	**Average Uses/Unit /Day**	**Unit**	**Baseline Water/Unit**	**Existing Water/Unit**	**High-Efficiency Water/Unit**	**Baseline Water/Year (GAL)**	**Existing Water/Year (GAL)**	**High-Efficiency/Year (GAL)**
Water Closet	120	3	Flushes	1.6	1.6	.8	210,240	210,240	105,120
Urinal	5	3	Flushes	1	1	0.125	5,475	5,475	684
Private Faucets	67	.75	Minutes	2.2	.5	.5	40,350	9,170	9,170
Public Faucets	56	.75	Minutes	.5	.5	.5	7,665	7,665	7,665
						Total Gal/Year	263,730	232,550	122,639
						% Water Savings/Year	-	**11.8%**	**53.4%**

Table 27: Water Reduction Savings/Gallon Breakdown

From the above analysis, by using the fixtures currently in the design of the Global Vascular Institute, only an 11.8% water reduction is achieved. With the installation of high-efficiency water fixtures, the minimum of a 20% water reduction is greatly surpassed by obtaining a 53.4% water savings.

Cost Summary

Table 28 below shows the cost breakdown for installing the high-efficiency fixtures in the Global Vascular Institute. The costs for each fixture were determined through product data obtained from different manufacturers. These costs only account for the materials costs and not the costs of labor to install the fixtures. It is important to note that these fixture costs do not take into account the cost savings from the reduction of water throughout the building.

WATER REDUCTION FIXTURE COST					
Fixture	**Quantity**	**Baseline Cost/Fixture**	**High-Efficiency Cost/Fixture**	**Baseline Cost**	**High-Efficiency Cost**
Water Closet	120	$150.00	$308.00	$18,000	$36,960
Urinal	5	$288.00	$350.00	$1,440	$1,750
Private Faucets	67	$150	$450.00	$10,050	$30,150
Public Faucets	56	$450.00	$450.00	$25,200	$25,200
			Total Cost	$54,690	$94,060
				Cost Difference	**$39,370**

Table 28: Water Reduction Fixture Cost Breakdown

Additional Thoughts

See Appendix J for water fixture product data.

Water Efficiency Credit 1: Water Efficient Landscaping (2-4 Points)

Intent

To limit or eliminate the use of potable water or other natural surface or subsurface water resources available on or near the project site for landscape irrigation

Requirements

Option 1: Reduce by 50% (2 Points)

Reduce potable water consumption for irrigation by 50% from a calculated midsummer baseline case. Reductions must be attributed to any combination of the following items:

- Plant species, density and microclimate factor
- Irrigation efficiency
- Use of captured rainwater
- Use of recycled wastewater
- Use of water treated and conveyed by a public agency specifically for non-potable uses

OR

Option 2: No Potable Water Use or Irrigation (4 Points)

Meet the requirements for Option 1

AND

Path 1

Use only captured rainwater, recycled wastewater, recycled graywater or water treated and conveyed by a public agency specifically for non-potable used for irrigation

OR

Path 2

Install landscaping that does not require permanent irrigation systems. Temporary irrigation systems used for plant establishment are allowed is only removed within 1 year of installation.

Potential Strategies

Perform a soil/climate analysis to determine appropriate plant material and design the landscape with native or adapted plants to reduce or eliminate irrigation requirements. Where irrigation is required, use high-efficiency equipment and/or climate-based controllers.

Analysis within the Global Vascular Institute

For the Global Vascular Institute the first 2 points of the Water Efficiency Credit 1 are obtained because all of the plantings on the site are native to the region so they require no irrigation.

The second 2 points of this credit are also obtainable by following Path 2 of Option 2. Since all of the plants on the site are indigenous to the area and do not require extra irrigation for survival.

Cost Summary

No additional cost for the project is sustained because the design of indigenous plants for the landscaping was included into the original design of the project.

Additional Thoughts

None

Water Efficiency Credit 2: Innovative Wastewater Technologies (2 Points)

Intent
To reduce wastewater generation and potable water demand while increasing the local aquifer recharge.

Requirements
Option 1

Reduce potable water use for building sewage conveyance by 50% through the use of water-conserving fixtures (e.g., water closets, urinals) or non-potable water (e.g., captured rainwater, recycled graywater, on-site or municipally treated wastewater).

OR

Option2

Treat 50% of wastewater on-site to tertiary standards. Treated water must be infiltrated or used on-site.

Potential Strategies
Specify high-efficiency fixtures and dry-fixtures (e.g., composting toilet systems, non-water using urinals) to reduce wastewater volumes. Consider reusing stormwater or graywater for sewage conveyance or on-site mechanical and/or natural wastewater treatment systems. Options for on-site wastewater treatment include packages biological nutrient removal systems, constructed wetlands and high-efficiency filtration systems.

Analysis within the Global Vascular Institute

POTABLE WATER REDUCTION									
Fixture	**Quantity**	**Average Uses/Unit /Day**	**Unit**	**Baseline Water/ Unit**	**Existing Water/ Unit**	**High-Efficiency/Unit**	**Baseline Water/Year (GAL)**	**Existing Water/Year (GAL)**	**High-Efficiency/Year (GAL)**
Water Closet	120	3	Flushes	1.6	1.6	0.8	210,240	210,240	105,120
Urinal	5	3	Flushes	1	1	.125	5,475	5,475	684
						Total Gal/Year	**215,715**	**215,715**	**105,804**
						% Water Savings/Year	-	**0%**	**50.9%**

Table 29: Potable Water Reduction Breakdown

Table 29 above shows that with the use of high-efficiency water closets and urinals, 50.9% of potable water can be saved each year in the Global Vascular Institute. Because of this Water Efficiency Credit 2 can be obtained. With the use of non-water urinals, an additional 3% of potable water could be reduced but since this the Global Vascular Institute is a hospital, these fixtures should not be used because of the risk of infection to the patients.

Cost Summary
No additional cost to the project is sustained because the cost of these high-efficiency fixtures is already included in the Water Efficiency Prerequisite Credit.

Additional Thoughts
None

Water Efficiency Credit 3: Water Use Reduction (2-4 Points)

Intent
To further increase water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.

Requirements
Employ strategies that in aggregate use less water than the water use baseline calculated for the building (not including irrigation). The minimum water savings percentage for each point threshold is as follows:

Percentage Reduction	Points
30%	2
35%	3
40%	4

Calculate the baseline according to the commercial and/or residential baselines outlines below. Calculations are based on estimated occupant usage and must include only the following fixtures and fixture fittings (as applicable to the project scope): water closets, urinals, lavatory faucets, showers, kitchen sink faucets and pre-rinse spray valves.

Commercial Fixtures, Fittings, and Appliances	Current Baseline
Commercial toilets	1.6 gallons per flush (gpf)* Except blow-out fixtures: 3.5 (gpf)
Commercial urinals	1.0 (gpf)
Commercial lavatory (restroom) faucets	2.2 gallons per minute (gpm) at 60 pounds per square inch (psi), private applications only (hotel or motel guest rooms, hospital patient rooms) 0.5 (gpm) at 60 (psi)** all others except private applications 0.25 gallons per cycle for metering faucets
Commercial prerinse spray valves (for food service applications)	Flow rate ≤ 1.6 (gpm) (no pressure specified; no performance requirement)

Potential Strategies
WaterSense-certified fixtures and fixture fittings should be used where available. Use high-efficiency fixtures (e.g., water closets and urinals) and dry fixtures, such as toilets attached to composting systems, to reduce potable water demand. Consider using alternative on-site sources of water (e.g., rainwater, stormwater, and air conditioner condensate) and graywater for non-potable applications such as custodial uses and toilet and urinal flushing. The quality of any alternative source of water used must be taken into consideration based on its application or use.

Analysis within the Global Vascular Institute
To calculate the water reduction necessary to obtain this credit, the baseline quantities, the current quantities and high-efficiency quantities from the water fixtures for the Global Vascular Institute were compared. Since there are very few urinals located within the building since most

of the restrooms are same sex single facilities, it was assumed that the number of uses for each water closet per day is the same. It is also important to note the difference between the private and public faucets throughout the building. The private faucets account only for all of the faucets used in patient's rooms.

WATER REDUCTION SAVINGS/GALLON									
Fixture	**Quantity**	**Average Uses/Unit /Day**	**Unit**	**Baseline Water/Unit**	**Existing Water/Unit**	**High-Efficiency Water/Unit**	**Baseline Water/Year (GAL)**	**Existing Water/Year (GAL)**	**High-Efficiency/Year (GAL)**
Water Closet	120	3	Flushes	1.6	1.6	.8	210,240	210,240	105,120
Urinal	5	3	Flushes	1	1	0.125	5,475	5,475	684
Private Faucets	67	.75	Minutes	2.2	.5	.5	40,350	9,170	9,170
Public Faucets	56	.75	Minutes	.5	.5	.5	7,665	7,665	7,665
						Total Gal/Year	263,730	232,550	122,639
						% Water Savings/Year	-	**11.8%**	**53.4%**

Table 30: Water Reduction Savings/gallon Breakdown

From the above analysis in table 30, by using the fixtures currently in the design of the Global Vascular Institute, only an 11.8% water reduction is achieved. With the installation of high-efficiency water fixtures a 53.4% water savings is obtained.

Cost Summary

No additional cost to the project is sustained because the cost of these high-efficiency fixtures is already included in the Water Efficiency Prerequisite Credit. It is important to note that because of the reduction in water used in the building, there will be a cost savings. This savings though is not included in this analysis.

Additional Thoughts

See Appendix J for water fixture product data.

Energy and Atmosphere Prerequisite 1: Fundamental Commissioning of Building Energy Systems (Required)

Intent
To verify that the project's energy-related systems are installed, and calibrated to perform according to the owner's project requirements, basis of design and construction documents. Benefits of commissioning include reduced energy use, lower operating costs, fewer contractor callbacks, better buildings documentation, improved occupant productivity and verification that the systems perform in accordance with the owner's project requirements.

Requirements
The following commissioning process activities must be completed by the project team:

- Designate an individual as the commissioning authority (CxA) to lead, review and oversee the completion of the commissioning process activities
    - The CxA must have documented commissioning authority experience in at least 2 building projects.
    - The individual serving as the CxA must be independent of the project design and construction management, though the CxA may be an employee of any firm providing those services. The CxA may be a qualified employee or consultant of the owner.
    - The CxA must report results, findings and recommendations directly to the owner.
- The owner must document the owner's project requirements. The design team must develop the basis of design. The CxA must review these documents for clarity and completeness. The owner and design team must be responsible for updates to their respective documents.
- Develop and incorporate commissioning requirements into the construction documents.
- Develop and implement a commissioning plan.
- Verify the installation and performance of the systems to be commissioned.
- Complete a summary commissioning report.

Commissioned Systems
Commissioning process activities must be completed for the following energy-related systems, at a minimum:

- Heating, ventilating, air conditioning and refrigeration (HVAC&R) systems (mechanical and passive) and associated controls
- Lighting and day lighting controls
- Domestic hot water systems
- Renewable energy systems (e.g., wind, solar)

Potential Strategies
Engage a CxA as early as possible in the design process. Determine the owner's project requirements, develop and maintain a commissioning plan for use during design and construction and incorporate commissioning requirements in bid documents. Assemble the commissioning

team, and prior to occupancy verify the performance of energy consuming systems. Complete the commissioning reports with recommendations prior to accepting the commissioned systems. Owners are encouraged to seek out qualified individuals to lead the commissioning process. Qualified individuals are identified as those who possess a high level of experience in the following areas:

- Energy systems design, installation and operation
- Commissioning planning and process management
- Hands-on field experience with energy systems performance, interaction, start-up, balancing, testing, troubleshooting, operation and maintenance procedures
- Energy systems automation control knowledge

Analysis within the Global Vascular Institute

From the beginning of the project, commissioning has been involved in the Global Vascular Institute so this Energy and Atmosphere Prerequisite is obtained.

Cost Summary

No additional cost to the project is sustained because the cost of commissioning is already included in the original cost of the building.

Additional Thoughts

None

Energy and Atmosphere Prerequisite 2: Minimum Energy Performance (Required)

Intent
To establish the minimum level of energy efficiency for the proposed building and systems to reduce environmental and economic impacts associated with excessive energy use.

Requirements
Option 1: Whole Building energy Simulation

Demonstrate a 10% improvement in the proposed building performance rating for new buildings, a 5% improvement in the proposed building performance rating for major renovation to existing buildings, compared with the baseline building performance rating. Calculate the baseline building performance rating according to the building performance rating method in Appendix G of ANSI/ASHRAE/IESNA a standard 90.1-2007 (with errata but without addenda) using a computer simulation model for the whole building project.

Potential Strategies
Design the building envelope and systems to meet baseline requirements. Use a computer simulation model to assess the energy performance and identify the most cost-effective measures. Quantify energy performance compared with a baseline building.

Analysis within the Global Vascular Institute
The Carrier Hourly Analysis Program was used to determine the energy performance or the Global Vascular Institute. To determine the energy savings, a baseline energy usage for the building had to be determined to compare the energy usage of the Global Vascular Institute against.

The assumptions used when designing the systems for the baseline energy usage that meet the ANSI/ASHRAE/IESNA standard are as follows:

- Wall Type – Light Wall Construction
- Roof Type – Medium Roof Construction
- Standard Glass - 25% of wall area
- 25 CFM/Person
- 1.8 w/ft² Interior Lighting
- 2.2 w/ft² Electrical Equipment
- Chilled Water AHU’s with a VAV reheat system
- Heating Via Hot Water
- 2 Chillers with Cooling Towers

The assumptions used when determining the energy usage for the Global Vascular Institute are as follows:

- Wall Type – Light Wall Construction
- Roof Type – Medium Roof Construction
- High Efficiency Glass - 55% of wall area
- 25 CFM/Person
- 1.0 w/ft² Interior Lighting
- 2.2 w/ft² Electrical Equipment
- Chilled Water AHU's with a VAV reheat
- Heating Via Steam
- 2 Chillers with Cooling Towers

Using the Carrier Hourly Analysis Program, a 13.9% energy savings was calculated.

Cost Summary
No additional cost to the project is sustained because the results of the Carrier Hourly Analysis Report show that there is greater than the 10% improvement in energy required.

It is important to note though that there would be soft costs to this credit because the building would need to be professionally modeled. These costs are included in the soft costs estimate in Section 7.5.1 Soft Costs.

Additional Thoughts
See Appendix K for the results of the Energy Analysis Report.

Energy and Atmosphere Prerequisite 3: Fundamental Refrigerant Management (Required)

Intent
To reduce stratospheric ozone depletion.

Requirements
Zero use of chlorofluorocarbon (CFC) – based refrigerants in new base building heating, ventilating, air conditioning and refrigeration (HVAC&R) systems. When reusing existing base building HVAC equipment, complete a comprehensive CFC phase-out conversion prior to project completion. Phase-out plans beyond the project completion date will be considered on their merits.

Potential Strategies
When reusing existing HVAC systems, conduct an inventory to identify equipment that uses CFC-based refrigerants and provide a replacement schedule for these refrigerants. For new buildings, specify new HVAC equipment in the base building that uses no CFC-based refrigerants.

Analysis within the Global Vascular Institute
The Global Vascular Institute uses no CFC-based refrigerants in the HVAC systems in the building so this prerequisite is obtained.

Cost Summary
No additional cost to the project is sustained because no CFC-based refrigerants are in the original design of the building.

Additional Thoughts
None

Energy and Atmosphere Credit 1: Optimize Energy Performance (1-19 Points)

Intent
To achieve increasing levels of energy performance beyond the prerequisite standard to reduce environmental and economic impacts associated with excessive energy use.

Requirements
Demonstrate a percentage improvement in the proposed building performance rating compared with the baseline building performance rating. Calculate the baseline building performance according to Appendix G of ANSI/ASHRAE/IESNA Standard 90.1-2007 (with errata but without addenda) using a computer simulation model for the whole building project. The minimum energy cost savings for each point threshold is as follows:

New Buildings	Existing Building Renovations	Points
12%	8%	1
14%	10%	2
16%	12%	3
18%	14%	4
20%	16%	5
22%	18%	6
24%	20%	7
26%	22%	8
28%	24%	9
30%	26%	10
32%	28%	11
34%	30%	12
36%	32%	13
38%	34%	14
40%	36%	15
42%	38%	16
44%	40%	17
46%	42%	18
48%	44%	19

Potential Strategies
Design the building envelope and systems to maximize energy performance. Use a computer simulation model to assess the energy performance and identify the most cost-effective energy efficiency measures. Quantify energy performance compared with a baseline building.

Analysis within the Global Vascular Institute
The Carrier Hourly Analysis Program was used to determine the energy performance or the Global Vascular Institute. To determine the energy savings, a baseline energy usage for the building had to be determined to compare the energy usage of the Global Vascular Institute against.

The assumptions used when designing the systems for the baseline energy usage that meet the ANSI/ASHRAE/IESNA standard are as follows:

- Wall Type – Light Wall Construction
- Roof Type – Medium Roof Construction
- Standard Glass - 25% of wall area
- 25 CFM/Person
- 1.8 w/ft² Interior Lighting
- 2.2 w/ft² Electrical Equipment
- Chilled Water AHU's with a VAV reheat system
- Heating Via Hot Water
- 2 Chillers with Cooling Towers

The assumptions used when determining the energy usage for the Global Vascular Institute are as follows:

- Wall Type – Light Wall Construction
- Roof Type – Medium Roof Construction
- High Efficiency Glass - 55% of wall area
- 25 CFM/Person
- 1.0 w/ft² Interior Lighting
- 2.2 w/ft² Electrical Equipment
- Chilled Water AHU's with a VAV reheat
- Heating Via Steam
- 2 Chillers with Cooling Towers

Using the Carrier Hourly Analysis Program, a 13.9% energy savings was calculated. Since this is just below 14%, the Global Vascular Institute only earns 1 point for this credit at 12% improvement in energy.

Cost Summary
No additional cost to the project is sustained because no additional analysis was performed to determine any additional energy improvements to the project.

It is important to note though that there would be soft costs to this credit because the building would need to be professionally modeled. These costs are included in the soft costs estimate in Section 7.5.1 Soft Costs.

Additional Thoughts
See Appendix K for the results of the Energy Analysis Report.

Energy and Atmosphere Credit 2: On-Site Renewable Energy (1-7 Points)

Intent
To encourage and recognize increasing levels of on-site renewable energy self-supply to reduce environmental and economic impacts associated with fossil fuel energy use.

Requirements
Use on-site renewable energy systems to offset building energy costs. Calculate project performance by expressing the energy produced by the renewable systems as a percentage of the building's annual energy cost and use the table below to determine the number of points achieved. Use the building annual energy cost calculated in EA Credit 1: Optimize Energy Performance or the U.S. Department of Energy's Commercial Buildings Energy Consumption Survey database to determine the estimated electricity use. The minimum renewable energy percentage for each point threshold is as follows:

Percentage Renewable Energy	Points
1%	1
3%	2
5%	3
7%	4
9%	5
11%	6
13%	7

Potential Strategies
Assess the project for nonpolluting and renewable energy potential including solar, wind, geothermal, low-impact hydro, biomass, and bio-gas strategies. When applying these strategies, take advantage of net metering with the local utility.

Analysis within the Global Vascular Institute
In the original design of the Global Vascular Institute, no renewable energy systems were incorporated. The type of renewable energy system that will be analyzed in for this credit will be a photovoltaic system located on the roof of the building. Table 31 below shows information necessary to properly size the PV system for the Global Vascular Institute.

GENERAL BUILDING INFORMATION	
Sun Hours/Day	3.31
Total Building Energy Usage (kW)	4,408,000

Table 31: General Information needed for the photovoltaic system

Cost Summary

Table 32 below shows the amount of Watts required for each % of building energy to obtain LEED points. The cost of each size system as well as the payback period is also shown. From this cost analysis, to obtain all 7 points for this credit, an additional cost of $5,730,000 would be sustained to the Global Vascular Institute. It would also take 25 years to start earning a return on the installation of the photovoltaic system.

PHOTOVOLTAIC SYSYTEM ENERGY PRODUCTION AND COST			
% of Building using Renewable Energy	Wattage of System Required (kW)	Total Cost of System (Materials & Installation) ($10,000/kW)	Payback Period (Years)
1%	44	$440,000	22
3%	132	$1,320,000	24
5%	220	$2,200,000	25
7%	309	$3,090,000	27
9%	397	$3,970,000	25
11%	485	$4,850,000	25
13%	573	$5,730,000	25

Table 32: Breakdown of PV System Energy Production, Cost, and Payback Period

Additional Thoughts

See Appendix L for the detailed results of the Roof Photovoltaic System Payback Period.

Energy and Atmosphere Credit 3: Enhanced Commissioning (2 Points)

Intent

To begin the commissioning process early in the design process and execute additional activities after systems performance verification completed.

Requirements

Implement, or have a contract in place to implement, the following additional commissioning process activities in addition to the requirements of EA Prerequisite 1: Fundamental Commissioning of Building Energy Systems and in accordance with the LEED Reference Guide for Green Building Design and Construction, 2009 Edition:

- Prior to the start of the construction documents phase, designate an independent commissioning authority (CxA) to lead, review and oversee the completion of all commissioning process activities.
  - The CxA must have documented commissioning authority experience in at least 2 buildings projects.
  - The individual independent of the work of design and construction.
    - Must not be an employee of the design firm, though he or she may be contracted through them.
    - Must not be an employee of, or contracted through, a contractor or construction manager holding construction contracts.
    - May be a qualified employee or consultant of the owner.
  - The CxA must report results, finding and recommendations directly to the owner.
- The CxA must conduct, at a minimum, 1 commissioning design review of the owner's project requirements basis of design, and design documents prior to the mid-construction documents phase and back-check the review comments in the subsequent design submission.
- The CxA must review contractor submittals applicable to systems being commissioned for compliance with the owner's project requirements and basis of design. This review must be concurrent with the review of the architect or engineer of record and submitted to the design team and the owner.
- The CxA must be involved interviewing the operation of the building with operations and maintenance (O&M) staff and occupants within 10 months after substantial completion. A plan resolving outstanding commissioning-related issues must be included.

Potential Strategies

Although it is preferable that the CxA be contracted by the owner, for the enhanced commissioning credit the CxA may also be contracted through the design firms or construction management firms not holding construction contracts. The CxA must complete all of the following process activities: commissioning design review, commissioning submittal review, and a systems manual.

Analysis within the Global Vascular Institute

From the beginning of the project, commissioning has been involved in the Global Vascular Institute so this Energy and Atmosphere Prerequisite is obtained.

Cost Summary

No additional cost to the project is sustained because the cost of commissioning is already included in the original cost of the building.

Additional Thoughts

None

Energy and Atmosphere Credit 4: Enhanced Refrigerant Management (2 Points)

Intent

To reduce ozone depletion and support early compliance with the Montreal Protocol while minimizing direct contributions to climate change.

Requirements

Option 1

Do not use refrigerants.

OR

Option 2

Select refrigerants and heating, ventilation, air conditioning and refrigeration (HVAC&R) equipment that minimize or eliminate the emission of compounds that contribute to ozone depletion and climate change. The base building HVAC&R equipment must comply with the following formula, which sets a maximum threshold for the combined contributions to ozone depletion and global warming potential:

$$LCGWP + LCODP \times 10^5 \leq 100$$

Calculation definitions for $LCGWP + LCODP \times 10^5 \leq 100$
LCODP = [ODPr x (Lr x Life +Mr) x Rc]/Life
LCGWP = [GWPr x (Lr x Life +Mr) x Rc]/Life
LCODP: Lifecycle Ozone Depletion Potential (lb CFC 11/Ton-Year)
LCGWP: Lifecycle Direct Global Warming Potential (lb CO_2/Ton-Year)
GWPr: Global Warming Potential of Refrigerant (0 to 12,000 lb CO_2/lbr)
ODPr: Ozone Depletion Potential of Refrigerant (0 to 0.2 lb CFC 11/lbr)
Lr: Refrigerant Leakage Rate (0.5% to 2.0%; default of 2% unless otherwise demonstrated)
Mr: End-of-life Refrigerant Loss (2% to 10%; default of 10% unless otherwise demonstrated)
Rc: Refrigerant Charge (0.5 to 5.0 lbs of refrigerant per ton of gross ARI rated cooling capacity)
Life: Equipment Life (10 years; default based on equipment type, unless otherwise demonstrated)

Potential Strategies

Design and operate the facility without mechanical cooling and refrigeration equipment. Where mechanical cooling is used, utilize base building HVAC&R systems for the refrigeration cycle that minimizes direct impact on ozone depletion and global climate change. Select HVAC&R equipment with refrigerant charge and increased equipment life. Maintain equipment to prevent leakage of refrigerant to the atmosphere. Use fire suppression systems that do not contain HCFCs or halons.

Analysis within the Global Vascular Institute

The Global Vascular Institute uses refrigerants in its HVAC&R system design so Option 1 is not applicable. Option 2 is obtainable though because all of the refrigerants used meet the required criteria.

Cost Summary

No additional cost to the project is sustained because all the refrigerants in the original design meet the criteria described in Option 2 of this credit.

Additional Thoughts

None

Energy and Atmosphere Credit 5: Measurement and Verification (3 Points)

Intent
To provide for the ongoing accountability of building energy consumption over time.

Requirements
Option 1

Develop and implement a measurement and verification (M&V) plan. The M&V period must cover at least 1 year of post-construction occupancy. Provide a process for corrective action if the results of the M&V plan indicate that energy savings are not being achieved.

Potential Strategies
Develop an M&V plan to evaluate building and/or energy system performance. Characterize the building and/or energy systems through energy simulation or engineering analysis. Install the necessary metering equipment to measure energy use. Track performance by comparing predicted performance to actual performance, broken down by component or system as appropriate. Evaluate energy efficiency by comparing actual performance to baseline performance.

Analysis within the Global Vascular Institute
In the original design of the Global Vascular Institute, there are only metering systems for the HVAC systems. There are no meters for the electrical system.

Cost Summary
To obtain the Energy and Atmosphere Credit 5: Measurement and Verification, the cost of installing electrical meters was calculated. Table 33 below shows the breakdown of installing these meters. The cost/SF was obtained from the *GSA LEED Cost Study*. Additional costs will be required to monitor and verify system but these costs are included in the soft costs for the building and are not included in the installation cost.

METER INSTALLATION COST		
Building Square Footage	**Cost/SF**	**Total Cost**
450,000	$0.40	$180,000

Table 33: Meter Installation Cost Breakdown

Additional Thoughts
None

Energy and Atmosphere Credit 6: Green Power (2 Points)

Intent
To encourage the development and use of grid-source, renewable energy technologies on a net zero pollution basis.

Requirements
Engage in at least a 2-year renewable energy contract to provide at least 35% of the building's electricity from renewable sources, as defined by the Center of Resource Solutions' Green-e Energy product certification requirements. All purchases of green power shall be based on the quantity of energy consumed, not the cost.

Option 1: determine Baseline Electricity Use
Use the annual electricity consumption from the results of Energy and Atmosphere Credit 1: Optimize Energy Performance.
OR
Option 2
Use the U.S. Department of Energy's Commercial Buildings Energy Consumption Survey database to determine the estimated electricity use.

Potential Strategies
Determine the energy needs of the building and investigate opportunities to engage in a green power contract. Green power is derived from solar, wind, geothermal, biomass or low-impact hydro sources.

Analysis within the Global Vascular Institute
New York State offers commercial buildings to purchase renewable energy from *GreenUp Providers* for an additional cost per kWhr.

Cost Summary
Table 34 below shows the extra cost of using renewable energy for the Global Vascular Institute for 2 years. These prices were obtained from data available at http://www. nationalgridus.com; the supplier of electricity to this project.

COST OF GREEN POWER CONTRACT				
Energy Type	**Extra Cost/kWhr**	**kWhr/Year (35% of Total kWhr)**	**# of Years**	**Total Cost**
Wind (50%)	$0.01	771400	2	$15,428
Small Hydro (50%)	$0.01	771400	2	$15,428
			Total Cost	**$30,856**

Table 34: Breakdown of the Cost of Renewable Energy for 2 a year contract

Additional Thoughts
None

Materials and Resources Prerequisite 1: Storage and Collection of Recyclables (Required)

Intent
To facilitate the reduction of waste generated by building occupants that is hauled to and disposed of in landfills.

Requirements
Provide an easily-accessible dedicated area or areas for the collection and storage of materials for recycling for the entire building. Materials must include, at a minimum: paper, corrugated cardboard, glass, plastics and metals.

Potential Strategies
Designate an area for recyclable collection and storage that is appropriately sized and located in a convenient area. Identify local waste handlers and buyers for glass, plastic, metals, office paper, newspaper, cardboard and organic wastes. Instruct occupants on recycling procedures. Consider employing cardboard balers, aluminum can crushers, recycling chutes and other waste management strategies to further enhance the recycling program.

Analysis within the Global Vascular Institute
During the construction of the Global Vascular Institute, a recycling system was set up to account for the removal of some of the waste materials.

Cost Summary
No additional cost to the project is sustained because the cost of recycling is included in the original cost of the building.

Additional Thoughts
None

Material and Resources Credit 1.1: Building Reuse – Maintain Existing Walls, Floors and Roof (1-3 Points)

Intent
To extend the lifecycle of existing building stock, conserve resource, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

Requirements
Maintain the existing building structure (including structural floor and roof decking) and envelop (the exterior skin and framing, excluding window assemblies and no-structural roofing material). The minimum percentage building reuse for each point threshold is as follows:

Building Reuse	Points
55%	1
75%	2
95%	3

Hazardous materials that are remediated as a part of the project must be excluded from the calculation of the percentage maintained. If the project includes an addition that is more than 2 times the square footage of the existing building, this credit is not applicable.

Potential Strategies
Consider reusing existing, previously-occupied building structures, envelopes and elements. Remove elements that pose a contamination risk to building occupants and upgrade components that would improve energy and water efficiency such as windows, mechanical systems, and plumbing fixtures.

Analysis within the Global Vascular Institute
Since the Global Vascular Institute is a new construction building, this credit is not obtainable.

Cost Summary
No additional cost to the project is sustained because this credit is not obtainable.

Additional Thoughts
None

Materials and Resources Credit 1.2: Building Reuse–Maintain Interior Nonstructural Elements (1 Point)

Intent
To extend the lifecycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

Requirements
Use existing interior nonstructural elements (e.g., interior walls, doors, floor coverings and ceiling systems) in at least 50% (by area) of the completed building, including additions. If the project includes an addition with square footage more than 2 times the square footage of the existing building, this credit is not applicable.

Potential Strategies
Consider reusing existing building structures, envelopes and interior nonstructural elements. Remove elements that pose a contamination risk to building occupants, and upgrade components that would improve energy and water efficiency such as mechanical systems and plumbing fixtures. Quantify the extent of building reuse.

Analysis within the Global Vascular Institute
Since the Global Vascular Institute is a new construction building, this credit is not obtainable.

Cost Summary
No additional cost to the project is sustained because this credit is not obtainable.

Additional Thoughts
None

Materials and Resources Credit 2: Construction Waste Management

Intent
To divert construction and demolition debris from disposal in landfills and incineration facilities. Redirect recyclable recovered resources back to the manufacturing process and reusable materials to appropriate sites.

Requirements
Recycle and/or salvage nonhazardous construction and demolition debris. Develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or comingled. Excavated soil and land-clearing debris do not contribute to this credit. Calculations can be done by weight or volume, but must be consistent throughout. The minimum percentage debris to be recycled or salvaged for each point threshold is as follows.

Recycled or Salvaged	Points
50%	1
75%	2

Potential Strategies
Establish goals for diversion from disposal in landfills and incineration facilities and adopt a construction waste management plan to achieve these goals. Consider recycling cardboard, metal, brick, mineral fiber panel, concrete, plastic, clean wood, glass gypsum wallboard, carpet and insulation.

Analysis within the Global Vascular Institute
The Global Vascular Institute has no construction waste management plan designated in the original design.

Cost Summary
Using the GSA LEED Cost Study, a general estimate of the cost of achieving 50% and/or 75% recycled or salvaged debris is calculated in table 35 below.

RECYCLED OR SALVAGED DEBRIS COST			
% of Debris Recycled or Salvaged	**Building Total Square Footage**	**Cost/SF**	**Total Cost**
50%	450,000	$0.12	$54,000
75%	450,000	$0.20	$90,000

Table 35: Cost Breakdown of Recycled or Salvaged Debris for 50% or 75% of the

Additional Thoughts
None

Materials and Resources Credit 3: Materials Reuse (1-2 Points)

Intent

To reuse building materials and products to reduce demand for virgin materials and reduce waste, thereby lessoning impacts associated with the extraction and processing of virgin resources.

Requirements

Use salvaged, refurbished or reused materials, the sum of which constitutes at least 5% or 10%, based on cost, of the total value of materials on the project. The minimum percentage materials reused for each point threshold is as follows:

Reused Materials	Points
5%	1
10%	2

Mechanical, electrical and plumbing components and specialty items such as elevators and equipment cannot be included in this calculation. Include only materials permanently installed in the project. Furniture may be included if it is included consistently in MR Credit 3: Materials Reuse through MR Credit 7: Certified Wood.

Potential Strategies

Identify opportunities to incorporate salvaged materials into the building design, and research potential material suppliers. Consider salvaged materials such as beams and posts, flooring, paneling, doors and frames, cabinetry and furniture, brick, and decorative items.

Analysis within the Global Vascular Institute

As that the Global Vascular Institute is a hospital and medical research facility, the use of recycled materials would require extensive cleaning before installing in the building. This is because these recycled and salvaged materials create the risk of infection to the patients. Due to this, this credit will be considered not obtainable.

Cost Summary

No additional cost to the project is sustained because this credit is considered not obtainable.

Additional Thoughts

None

Materials and Resources Credit 4: Recycled Content (1-2 Points)

Intent
To increase demand for building products that incorporate recycled content materials, thereby reducing impacts resulting from extraction and processing of virgin materials.

Requirements
Use materials with recycled content such that the sum of postconsumer recycled content plus ½ of the pre-consumer content constitutes at least 10% or 20%, based on cost of the total value of the materials in the project. The minimum percentage materials recycled for each point threshold is as follows:

Recycled Content	Points
10%	1
20%	2

The recycled content value of a material assembly is determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value. Mechanical, electrical and plumbing components and specialty items such as elevators cannot be included in this calculation. Include only materials permanently installed in the project. Furniture may be included if it is included consistently in MR Credit 3: Materials Reuse through MR Credit 7: Certified Wood.

Potential Strategies
Establish a project goal for recycled content materials, and identify material suppliers that can achieve this goal. During construction, ensure that the specified recycled content materials are installed. Consider a range of environmental, economic and performance attributes when selecting products and materials.

Analysis within the Global Vascular Institute
A detailed analysis of the recycled content of materials for the Global Vascular Institute was not performed. Using the GSA LEED Cost Study, an estimate for the cost of 20% recycled content materials was calculated.

Cost Summary
Table 36 below shows the breakdown of cost of having 10% and 20% recycled content materials in the project. The cost for 10% recycled content material was interpolated from cost data for 20% recycled content material obtained from the GSA LEED Cost Study.

COST OF RECYCLED CONTENT MATERIALS			
% of Recycled Content	**Building Square Footage**	**Cost/SF**	**Total Cost**
10%	450,000	$0.15	$67,500
20%	450,000	$0.30	$135,000

Table 36: Cost Breakdown for 10% or 20% Recycled Content Materials

Additional Thoughts
None

Materials and Resources Credit 5: Regional Materials (1-2 Points)

Intent
To increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the use of indigenous resources and reducing environmental impacts resulting from transportation.

Requirements
Use building materials or products that have been extracted, harvested or recovered, as well as manufactured, within 500 miles of the project site for a minimum of 10% or 20%, based on cost, of the total materials value. If only a fraction of a product or material is extracted, harvested, or recovered and manufactured locally, then only that percentage (by weight) can contribute to the regional value. The minimum percentage regional materials for each point threshold are as follows:

Regional Materials	Points
10%	1
20%	2

Mechanical, electrical and plumbing components and specialty items such as elevators and equipment must not be included in this calculation. Include only materials permanently installed in the project. Furniture may be included if it is included consistently in MR Credit 3: Materials Reuse through MR Credit 7: Certified Wood.

Potential Strategies
Establish a project goal for locally sourced materials, and identify materials and material suppliers that can achieve this goal. During construction, ensure that the specified local materials are installed, and quantify the total percentage of local materials installed. Consider a range of environmental, economic and performance attributes when selecting products and materials.

Analysis within the Global Vascular Institute
For the Global Vascular Institute, only the structural steel contractor is located further than 500 miles from the project site. The cost of the structural steel only equates to about 12% of the buildings cost so the remaining 88% of the building is within 500 miles of the project site. Because of this, both of the points are obtainable.

Cost Summary
No additional cost to the project is sustained because more that 20% of the materials by cost are within 500 miles of the project site.

Additional Thoughts
None

Materials and Resources Credit 6: Rapidly Renewable Materials (1 Point)

Intent
To reduce the use and depletion of finite raw materials and long-cycle renewable materials by replacing them with rapidly renewable materials.

Requirements
Use rapidly renewable building materials and products for 2.5% of the total value of all building materials and products used in the project, based on cost. Rapidly renewable building materials and products are made from plants that are typically harvested within a 10-year or shorted cycle.

Potential Strategies
Establish a project goal for rapidly renewable materials, and identify products and suppliers that can support achievement of this goal. Consider materials such as bamboo, wool, cotton insulation, agrifiber, linoleum, wheatboard, strawboard and cork. During construction, ensure that the specified renewable materials are installed.

Analysis within the Global Vascular Institute
The Global Vascular Institute cannot incorporate any rapidly renewable materials in to the design of the building due to the strict requirements of the finishes since the building is classified as a hospital and medical research facility. Due to this, this point is considered not obtainable.

Cost Summary
No additional cost to the project is sustained because this credit is considered not obtainable.

Additional Thoughts
None

Materials and Resources Credit 7: Certified Wood (1 Point)

Intent
To encourage environmentally responsible forest management.

Requirements
Use a minimum of 50% (based on cost) of wood-based materials and products that are certified in accordance with the Forest Stewardship Council's principles and criteria, for wood building components. These components include at a minimum, structural framing and general dimensional framing, flooring sub-flooring, wood doors and finishes.

Include only materials permanently installed in the project. Wood products purchased for temporary use on the project (e.g., formwork, bracing scaffolding, sidewalk protection, and guard rails) must be included in the calculation at the project team's discretion. If any such materials are included, all such materials must be included in the calculation. If such materials are purchased for use on multiple projects, the applicant may include these materials for only one project, at its discretion. Furniture may be included if it is included consistently in MR Credits 3, Material Reuse, through MR Credit 7, Certified Wood.

Potential Strategies
Establish a project goal for FSC-certified wood products and identify suppliers that can achieve this goal. During construction, ensure that the FSC-certified wood products are installed and quantify the total percentage of FSC-certified wood products installed.

Analysis within the Global Vascular Institute
The cost of millwork on the Global Vascular Institute is about $2.8 million. From the GSA LEED Cost Study, it states that for new construction, the cost for this credit is $2.28/SF. Since the project from this study was a courthouse, there is substantially more wood products included in the design. Because of this and the millwork being a very low portion of the cost of the Global Vascular Institute, a cost of $30/SF will be assumed.

Cost Summary
Table 37 below shows the breakdown of cost for replacing all wood in original design with certified wood.

CERTIFIED WOOD COST		
Building Square Footage	**Cost/SF**	**Total Cost**
450,000	$0.30	$135,000

Table 37: Certified Wood Cost Breakdown

Additional Thoughts
None

Indoor Environmental Quality Prerequisite 1: Minimum Indoor Air Quality Performance (Required)

Intent

To establish minimum indoor air quality (IAQ) performance to enhance indoor air quality in buildings, thus contributing to the comfort and well-being of the occupants.

Requirements

Meet the minimum requirements of Sections 4 through 7 of ASHRAE Standard 62.1-2007, Ventilation for Acceptable Indoor Air Quality (with errata but without addenda).

AND

Case 1: Mechanically Ventilated Spaces

Mechanical ventilation systems must be designed using the ventilation rate procedure or the applicable local code, whichever is more stringent.

Case 2: Naturally Ventilated Spaces

Naturally ventilated buildings must comply with ASHRAE Standard 62.1-2007, Paragraph 5.1 (with errata but without addenda).

Potential Strategies

Design ventilation systems to meet or exceed the minimum outdoor air ventilation rates as describes in the ASHRAE standard. Balance the impacts of ventilation rates on energy use and indoor air quality to optimize for energy efficiency and occupant comfort. Use the ASHRAE Standard 62.1-2007 User's Manual (with errata but without addenda) for detailed guidance on meeting the referenced requirements.

Analysis within the Global Vascular Institute

The original design of the Global Vascular Institute meets the minimum requirements according to ASHRAE Standards so the prerequisite criteria are met.

Cost Summary

No additional cost to the project is sustained because the original design of the building meets minimum requirements of outlined by ASHRAE.

Additional Thoughts

None

Indoor Environmental Quality Prerequisite 2: Environmental Tobacco Smoke (ETS) Control (Required)

Intent

To prevent or minimize exposure of building occupants, indoor surfaces and ventilation air distribution systems to environmental tobacco smoke (ETS).

Requirements

Case 1: All Projects

Option 1

- Prohibit smoking in the building.
- Prohibit on-property smoking within 25 feet of entries, outdoor air intakes and operable windows. Provide signage to allow smoking in designated areas, prohibit smoking in designated areas or prohibit smoking on the entire property.

OR

Option 2

- Prohibit smoking in the building except in designated smoking areas.
- Prohibit on-property smoking within 25 feet of entries, outdoor air intakes and operable windows. Provide signage to allow smoking in designated areas, prohibit smoking in designated areas or prohibit smoking on the entire property.
- Provide designated smoking rooms designed to contain, capture and remove ETS from the buildings. At a minimum, the smoking room must be directly exhausted to the outdoors, away from air intakes and building entry paths, with no recirculation of ETS-containing air to nonsmoking areas and enclosed with impermeable deck-to-deck partitions. Operate exhaust sufficient to create a negative pressure differential with the surrounding spaces of at least an average of 5 Pascals (Pa) (0.02 inches of water gauge) and a minimum of 1 Pa (0.004 inches of water gauge) when the doors to the smoking rooms are closed.

Potential Strategies

Prohibit smoking in commercial buildings or effectively control the ventilation air in smoking rooms.

Analysis within the Global Vascular Institute

The Global Vascular Institute is a hospital and medical research facility so from the original design of the building, smoking is prohibited in or near the building. Because of this, the requirements of this prerequisite are achieved.

Cost Summary

No additional cost to the project is sustained because there is no smoking allowed in or near the building since it is a hospital.

Additional Thoughts

None

Indoor Environmental Quality Credit 1: Outdoor Air Delivery Monitoring (1 Point)

Intent

To provide capacity for ventilation system monitoring to help promote occupant comfort and well-being.

Requirements

Install permanent monitoring systems to ensure that ventilation systems maintain design minimum requirements. Configure all monitoring equipment to generate an alarm when airflow valves or carbon dioxide (CO2) levels vary by 10% or more from the design valves via either a building automation system alarm to the building operator or a visual or audible alert to the building occupants.

AND

Case 1: Mechanically Ventilated Spaces

Monitor CO2 concentrations within all densely occupied spaces (those with a design occupant density of 25 people or more per 1,000 square feet). CO2 monitors must be between 3 and 6 feet above the floor. Provide a direct outdoor airflow measurement device capable of measuring the minimum outdoor air intake flow with an accuracy of plus or minus 15% of the design minimum outdoor air rate, as defined by ASHRAE Standard 62.1-2007 (with errata but without addenda) for mechanical ventilation systems where 20% or more of the design supply airflow serves non-densely occupied spaces.

Case 2: Naturally Ventilated Spaces

Monitor CO2 concentrations within all naturally ventilated spaces. CO2 monitors must be between 3 and 6 feet above the floor. One CO2 sensor may be used to monitor multiple non-densely occupied spaces is the natural ventilation design uses passive stack(s) or other means to induce airflow through those spaces equally and simultaneously without intervention by building occupants.

Potential Strategies

Install CO2 and airflow measurement equipment and feed the information to the heating, ventilating and air conditioning (HVAC) system and/or building automation system (BAS) to trigger corrective action, if applicable. If such automatic controls are not feasible with the building systems, use the measurement equipment to trigger alarms that inform building operators or occupants of a possible deficiency in outdoor air delivery.

Analysis within the Global Vascular Institute

In the original design of the Global Vascular Institute, a CO2 and outdoor air intake monitoring system was included so IEQ credit 1 is obtained.

Cost Summary

No additional cost to the project is sustained because a CO2 and outdoor air intake monitoring system was in the original design of the building.

Additional Thoughts

None

Indoor Environmental Quality Credit 2: Increased Ventilation (1 Point)

Intent
To provide additional outdoor air ventilation to improve indoor air quality (IAQ) and promote occupant comfort, well-being and productivity.

Requirements
Case 1: Mechanically Ventilated Spaces

Increase breathing zone outdoor air ventilation rates to all occupied spaces by at least 30% above the minimum rates required by ASHRAE Standard 62.1-2007 (with errata but without addenda) as determined by IEQ Prerequisite 1: Minimum Indoor Air Quality Performance.

Case 2: Naturally Ventilated Spaces

Design natural ventilation systems for occupied spaces to meet the recommendations set forth in the Chartered Institution of Building Services Engineers (CIBSE) Applications Manual 10: 2005, National Ventilation in Non-domestic Buildings. Determine that natural ventilation is an effective strategy for the project by following the flow diagram process shown in Figure 2.8 of the CIBSE Applications Manual 10.

AND

Option 1

Use diagrams and calculations to show that the design of the natural ventilation systems meets the recommendations set forth in the CIBSE Applications Manual 10:2005, Natural Ventilation in Non-domestic Buildings, CIBSE AM 13 (Mixed Mode Ventilation), or natural ventilation/mixed mode ventilated related sections of the CIBSE Guide B2 (Ventilation and Air Conditioning).

OR

Option2

Use a macroscopic, multi-zone, analytic model to predict that room-by-room airflows will effectively naturally ventilate, defined as providing the minimum ventilation rates required by ASHRAE 62.1-2007 Chapter 6 (with errata but without addenda), for at least 90% of occupied spaces.

Potential Strategies
Design the space with at least 30% greater outside air than the minimum rates required by ASHRAE.

Analysis within the Global Vascular Institute
In the original design of the Global Vascular Institute, about 55% of outdoor air is supplied to the building. This is very typical for hospitals because of the requirements for exhausted air to reduce infection to patients. Because this is greater than the 30% required, this credit is obtained.

Cost Summary
No additional cost to the project is sustained.

Additional Thoughts
None

Indoor Environmental Quality Credit 3.1: Construction Indoor Air Quality Management Plan-During Construction (1 Point)

Intent
To reduce indoor air quality (IAQ) problems resulting from construction or renovation and promote the comfort and well-being of construction workers and building occupants.

Requirements
Develop and implement an IAQ management plan for the construction and preoccupancy phases of the buildings as follows:

- During construction, meet or exceed the recommended control measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines For Occupied Buildings Under Construction, 2nd Edition 2007, ANSI/SMACNA 008-2008 (Chapter 3).
- Protect stored on-site and installed absorptive materials from the moisture damage.
- If permanently installed air handlers are used during construction, filtration media with a minimum efficiency reporting value (MERV) of 8 must be used at each return air grille, as determined by ASHRAE Standard 52.2-1999 (with errata but without addenda). Replace all filtration media immediately prior to occupancy.

Potential Strategies
Adopt an IAQ management plan to protect the heating, ventilating and air conditioning (HVAC) system during construction, control pollutant sources and interrupt contamination pathways. Sequence the installation of materials to avoid contamination of absorptive materials.

Analysis within the Global Vascular Institute
From the beginning of the project, the construction management team has developed and followed a strict an IAQ management plan for the construction of the project since building is a hospital and medical research facility. Due to this, this credit is obtained.

Cost Summary
No additional cost to the project is sustained because an IAQ management plan is being implemented through the construction duration.

Additional Thoughts
None

Indoor Environmental Quality Credit 3.2: Construction Indoor Air Quality Management Plan-Before Occupancy (1 Point)

Intent
To reduce indoor air quality (IAQ) problems resulting from construction or renovation to promote the comfort and well-being of construction workers and building occupants.

Requirements
Develop an IAQ management plan and implement it after all finishes have been installed and the building has been completely cleaned before occupancy.

Option 1: Flush-Out

After construction ends, prior to occupancy and with all interior finishes installed, install new filtration media and, perform a building flush-out by supplying a total air volume of 14,000 cubic feet of outdoor air per square foot of floor area while maintaining an internal temperature of at least 60°F and relative humidity no higher than 60%.

OR

Option 2

Conduct baseline IAQ testing after construction ends and prior to occupancy using testing protocols consistent with the EPA Compendium of Methods for the Determination of Air Pollutants in Indoor Air and as additionally detailed in the LEED Reference Guide for Green Building Design and Construction, 2009 Edition.

Potential Strategies
Prior to occupancy, perform a building flush-out or test the air contaminant levels in the building.

Analysis within the Global Vascular Institute
Upon completion of the project, the building will be "flushed-out." This is very typical for hospitals so that the risk of infection to the patients is reduced. Because of this, this credit is obtained.

Cost Summary
No additional costs to the project are sustained because the cost of the building "flush-out" is included in the original cost the building.

Additional Thoughts
None

Indoor Environmental Quality Credit 4.1: Low-Emitting Materials Adhesives and Sealants (1 Point)

Intent
To reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants

Requirements
All adhesives and sealants used on the interior of the building (i.e., inside of the weatherproofing system and applied on-site) must comply with the following requirements as applicable to the project scope:

- Adhesives, Sealants and Sealant Primers must comply with South Coast Air Quality Management District (SCAQMD) Rule #1168.
- Aerosol Adhesives must comply with Green Seat Standard for Commercial Adhesives GS-36 requirements in effect on October 19, 2000.

Potential Strategies
Specify low-VOC materials in construction documents. Ensure that VOC limits are clearly stated in each section of the specifications where adhesives and sealants are addressed. Common products to evaluate include general construction adhesives, flooring adhesives, fire-stopping sealants, caulking, duct sealants, plumbing adhesives and cove base adhesives. Review product cut sheets, material safety data (MSD) sheets, signed attestations or other official literature from the manufacturer clearly identifying the VOC contents or compliance with referenced standards.

Analysis within the Global Vascular Institute
After reviewing the specifications of the project, it shows that low-emitting adhesives, sealants, paint, carpet, and composite wood products are to be used for the building. If not enough of these products are being used to meet the requirements of this credit though, more low-emitting products can be incorporated at no extra cost to the project. Because of this, the Global Vascular Institute obtains this credit.

Cost Summary
No additional cost to the project is sustained because there are low-emitting materials included into the project already and more can be incorporated because they are readily available in the market.

Additional Thoughts
None

Indoor Environmental Quality Credit 4.2: Low-Emitting Materials – Paint and Coatings (1 Point)

Intent
To reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants.

Requirements
Paints and coatings used on the interior of the building (i.e., inside of the weatherproofing system and applied on-site) must comply with the following criteria as applicable to the project scope:

- Architectural paints and coatings applied to interior walls and ceilings must not exceed the volatile organic compound (VOC) content limits established in Green Seal Standard GS-11, Paints, 1st Edition, May 20, 1993.
- Anti-corrosive and anti-rust paints applied to interior ferrous metal substrates must not exceed the VOC content limit of 250g/L established in Green Seal Standard GC-03, Anti-Corrosive Paints, 2nd Edition, January 7, 1997.
- Clear wood finishes, floor coatings, stains, primers, and shellacs applied to interior elements must not exceed the VOC content limits established in South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, rules in effect January 1, 2004.

Potential Strategies
Specify low-VOC paints and coatings in construction documents. Ensure that VOC limits are clearly stated in each section of the specifications where paints and coatings are addressed. Track the VOC content of all interior paints and coatings during construction.

Analysis within the Global Vascular Institute
After reviewing the specifications of the project, it shows that low-emitting adhesives, sealants, paint, carpet, and composite wood products are to be used for the building. If not enough of these products are being used to meet the requirements of this credit though, more low-emitting products can be incorporated at no extra cost to the project. Because of this, the Global Vascular Institute obtains this credit.

Cost Summary
No additional cost to the project is sustained because there are low-emitting materials included into the project already and more can be incorporated because they are readily available in the market.

Additional Thoughts
None

Indoor Environmental Quality Credit 4.3: Low-Emitting Materials – Flooring Systems (1 Point)

Intent
To reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants.

Requirements

Option 1
All flooring must comply with the following as applicable to the project scope:

- All carpet installed in the building interior must meet the testing and product requirements of the Carpet and Rug Institute Green Label Plus program.
- All carpet cushion installed in the building interior must meet the requirements of the Carpet and Rug Institute Green Label program.
- All carpet adhesive must meet the requirements of IEQ Credit 4.1: Adhesives and sealants, which includes a volatile organic compound (VOC) limit of 50g/L.
- All hard surface flooring must be certified as compliant with the FloorScore standard (current as of the date of this rating system, or more stringent version) by an independent third-party. Flooring products covered by FloorScore include vinyl, linoleum, laminate flooring, wood flooring, ceramic flooring, rubber flooring and wall base.
- Concrete, wood, bamboo and cork floor finishes such as sealer, stain and finish must meet the requirements of South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, rules in effect on January 1, 2004.

OR
Option 2
All flooring elements installed in the building interior must meet the testing and product requirements of the California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda.

Potential Strategies
Clearly specify requirements for product testing and/or certification in the construction documents. Select products that are either certified under the Green Label Plus program or for which testing has been done by qualified independent laboratories in accordance with the appropriate requirements.

Analysis within the Global Vascular Institute
After reviewing the specifications of the project, it shows that low-emitting adhesives, sealants, paint, carpet, and composite wood products are to be used for the building. If not enough of these products are being used to meet the requirements of this credit though, more low-emitting products can be incorporated at no extra cost to the project. Because of this, the Global Vascular Institute obtains this credit.

Cost Summary
No additional cost to the project is sustained because there are low-emitting materials included into the project already and more can be incorporated because they are readily available in the market.

Additional Thoughts
None

Indoor Environmental Quality Credit 4.4: Low-Emitting Materials-Composite Wood and Agrifiber Products (1 Point)

Intent
To reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants.

Requirements
Composite wood and agrifiber products used on the interior of the building (i.e., inside the weatherproofing system) must contain no added urea-formaldehyde resins. Laminating adhesives used to fabricate on-site and shop-applied composite wood and agrifiber assemblies must not contain added urea-formaldehyde resins. Composite wood and agrifiber products are defined as particleboard, medium density fiberboard (MDF), plywood, wheatboard, strawboard, panel substrates and door cores. Materials considered fixtures, furniture and equipment (FF&E) are not considered base building elements and are not included.

Potential Strategies
Specify wood and agrifiber products that contain no added urea-formaldehyde resins. Specify laminating adhesives for field and shop-applied assemblies that contain no added urea-formaldehyde resins. Review product cut sheets, material safety data (MSD) sheets, signed attestations or other official literature from the manufacturer.

Analysis within the Global Vascular Institute
After reviewing the specifications of the project, it shows that low-emitting adhesives, sealants, paint, carpet, and composite wood products are to be used for the building. If not enough of these products are being used to meet the requirements of this credit though, more low-emitting products can be incorporated at no extra cost to the project. Because of this, the Global Vascular Institute obtains this credit.

Cost Summary
No additional cost to the project is sustained because there are low-emitting materials included into the project already and more can be incorporated because they are readily available in the market.

Additional Thoughts
None

Indoor Environmental Quality Credit 5: Indoor Chemical and Pollutant Source Control (1 Point)

Intent
To minimize building occupant exposure to potentially hazardous particulates and chemical pollutant.

Requirements
Design to minimize and control the entry of pollutant into buildings and later cross-contamination of regularly occupied areas through the following strategies:

- Employ permanent entryway systems at least 10 feet long in the primary direction of travel to capture dirt and particles entering the building at regularly used exterior entrances. Acceptable entryway systems include permanently installed grates, grills and slotted systems that allow for cleaning underneath. Roll-out mats are acceptable only when maintained on a weekly basis by a contracted service organization.
- Sufficiently exhaust each space where hazardous gases or chemicals may be present or used (e.g., garages, housekeeping and laundry areas, copying and printing rooms) to create negative pressure with respect to adjacent spaces when the doors to the room are closed. For each of these spaces, provide self-closing doors and deck-to-deck partitions or a hard-lid ceiling. The exhaust rate must be at least 0.50 cubic feet per minute (cfm) per square foot with no air recirculation. The pressure differential with the surrounding spaces must be at least 5 Pascals (Pa) (0.02 inches of water gauge) on average and 1 Pa (0.004 inches of water) at a minimum when the doors to the rooms are closed.
- In mechanically ventilated buildings, install new air filtration media in regularly occupied areas prior to occupancy; these filters must provide a minimum efficiency reporting value (MERV) of 13 or higher. Filtration should be applied to process both return and outside air that is delivered as supply air.
- Provide contaminant (i.e., closed container for storage for off-site disposal in a regulatory compliant storage area, preferably outside the building) for appropriate disposal of hazardous liquid wastes in places where water and chemical concentrate mixing occurs (e.g., housekeeping, janitorial and science laboratories).

Potential Strategies
Design facility cleaning and maintenance areas with isolated exhaust systems for contaminants. Maintain physical isolation from the rest of the regularly occupied areas of the building. Install permanent architectural entryway systems such as grills or grates to prevent occupant-borne contaminants from entering the building.

Analysis within the Global Vascular Institute
After reviewing the construction documents, it was determined that the Global Vascular Institute has designated areas for collecting and disposing of hazardous materials. Because of this, this credit is obtained.

Cost Summary
No additional cost to the project is sustained because the original design of the building includes areas for collecting and disposing of hazardous wastes.

Additional Thoughts
None

Indoor Environmental Quality Credit 6.1: Controllability of Systems – Lighting (1 Point)

Intent
To provide a high-level of lighting system control by individual occupants or groups in multi-occupant spaces (e.g., classrooms and conference areas) and promote their productivity, comfort and well-being.

Requirements
Provide individual lighting controls for 90% (minimum of the building occupants to enable adjustments to suit individual task needs and preferences. Provide lighting system controls for all shared multi-occupant spaces to enable adjustments that meet group needs and preferences.

Potential Strategies
Design the building with occupant controls for lighting. Strategies to consider include lighting controls and task lighting. Integrate lighting systems controllability into the overall lighting design, providing ambient and task lighting while managing the overall energy use of the building.

Analysis within the Global Vascular Institute
Within the design of the Global Vascular Institute, there is some controllable lighting but not enough to meet the 90% required to obtain this credit. Most of the lighting control is occupant sensors and are located in the conference room areas but there are none in the patient rooms which make up a significant amount of the space in the building.

Cost Analysis
No cost analysis executed.

Additional Thoughts
None

Indoor Environmental Quality Credit 6.2: Controllability of Systems-Thermal Comfort (1 Point)

Intent
To provide a high level of thermal comfort system control by individual occupants or groups in multi-occupant spaces (e.g., classrooms or conference areas) and promote their productivity, comfort and well-being.

Requirements
Provide individual comfort controls for a 50% (minimum) of the building occupants to enable adjustments to meet individual needs and preferences. Operable windows may be used in lieu on controls for occupants located 20 feet inside and 10 feet to either side of the operable part of a window. The areas of operable window must meet the requirements of ASHRAE Standard 62.1-2007 paragraph 5.1 Natural Ventilation (with errata but without addenda). Provide comfort system controls for all shared multi-occupant spaces to enable adjustments that meet group needs and preferences. Conditions for thermal comfort are described in ASHRAE Standard 55-2004 (with errata but without addenda) and include the primary factors of air temperature, radiant temperature, air speed and humidity.

Potential Strategies
Design the building and systems with comfort controls to allow to suit individual needs or those of groups in shared spaces.

Analysis within the Global Vascular Institute
In the original design of the Global Vascular Institute, there are thermal controls for each space. These detect for the occupancy of the space as well as can be adjusted for occupant use. Because of this, this credit is obtained.

Cost Analysis
No additional cost to the project is sustained because a thermal control system was included in the original design of the building.

Additional Thoughts
None

Indoor Environmental Quality Credit 7.1: Thermal Comfort – Design (1 Point)

Intent
To provide a comfortable thermal environment that promotes occupant productivity and well-being.

Requirements
Design heating, ventilating and air conditioning (HVAC) systems and the building envelope to meet the requirements of ASHRAE Standard 55-2004, Thermal Comfort Conditions for Humanity Occupancy (with errata but without addenda). Demonstrate design compliance in accordance with the Section 6.1.1 documentation.

Potential Strategies
Establish comfort criteria according to ASHRAE 55-2004 (with errata but without addenda) that supports the desired quality and occupant satisfaction with building performance. Design the building envelope and systems with the capability to meet the comfort criteria under expected environmental and use conditions. Evaluate air temperature, radiant temperature, air speed and relative humidity in an integrated fashion, and coordinate these criteria with IEQ Prerequisite 1: Minimum IAQ Performance, IEQ Credit 1: Outdoor Air Delivery Monitoring, and IEQ Credit 2: Increased Ventilation.

Analysis within the Global Vascular Institute
The thermal comfort controls the Global Vascular Institute provides meet the ASHRAE Standard required for this credit. This was determined through information provided by the engineering team. Because of this, this credit is obtained.

Cost Summary
No additional cost to the project is sustained because the thermal comfort system meets the criteria required by the ASHRAE Standard.

Additional Thoughts
None

Indoor Environmental Quality Credit 7.2: Thermal Comfort – Verification (1 Point)

Intent
To provide for the assessment of building occupant thermal comfort over time.

Requirements

- Achieve IEQ Credit 7.1: Thermal Comfort – Design.
- Provide a permanent monitoring system to ensure that building performance meets the desired comfort criteria as determined by IEQ Credit 7.1: Thermal Comfort – Design.
- Agree to conduct a thermal comfort survey of building occupants within 6 to 18 months after occupancy. This survey should collect anonymous responses about thermal comfort in the building, including an assessment of overall satisfaction with thermal performance and identification of thermal comfort-related problems. Agree to develop a plan for corrective action if the survey results indicate that more than 20% of occupants are dissatisfied with thermal comfort in the building. This plan should include measurement of relevant environmental variables in problem areas in accordance with ASHRAE Standard 55-2004 (with errata but without addenda).

Potential Strategies
ASHRAE 55-2004 provides guidance for establishing thermal comfort criteria and documenting and validating building performance to the criteria. While the standard is not intended for purposes of continuous monitoring and maintenance of the thermal environment, the principles expressed in the standard provide a basis for the design of monitoring and corrective action systems.

Analysis within the Global Vascular Institute
After reviewing the specifications for the Global Vascular Institute, a monitoring system is included in the design of the building to verify the thermal comfort of the occupants. Because of this, this credit is obtained.

Cost Summary
No additional cost to the project is sustained because a monitoring system is included in the original design of the building.

Additional Thoughts
None

Indoor Environmental Quality Credit 8.1: Daylight and Views – Daylight (1 Point)

Intent
To provide building occupants with a connection between indoor spaces and the outdoor through the introduction of daylight and views into the regularly occupied areas of the building.

Requirements
Through 1 of the 4 options, achieve day lighting in at least the following spaces:

Regularly Occupied Spaces	Points
75%	1

Potential Strategies
Design the building to maximize interior day lighting. Strategies to consider include building orientation, shallow floor plates, increased building perimeter, exterior and interior permanent shading devices, high-performance glazing, and high-ceiling reflectance values; additionally, automatic photocell-based controls can help to reduce energy use.

Analysis within the Global Vascular Institute
Due to the nature of the facility, many of the regularly occupied spaces do not have any day lighting. These spaces include mostly operating rooms, labs, and procedure rooms. Because of this, the Global Vascular Institute does not meet the requirements for this credit.

Cost Summary
No additional cost to the project is sustained because this credit is not obtainable.

Additional Thoughts
None

Indoor Environmental Quality Credit 8.2: Daylight and Views – Views (1 Point)

Intent
To provide building occupants a connection to the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.

Achieve a direct line of sight to the outdoor environment via vision glazing between 30 inches and 90 inches above the finish floor for building occupants in 90% of all regularly occupied areas. Determine the area with a direct line of sight by totaling the regularly occupied square footage that meets the following criteria:

- In plan view, the area is within sight lines drawn from perimeter vision glazing.
- In section view, a direct sight line can be drawn from the area to the perimeter vision glazing.

The line of sight may be drawn through interior glazing. For private offices, the entire square footage of the office may be counted if 75% or more of the area has a direct line of sight to perimeter vision glazing. For multi-occupant spaces, the actual square footage with a direct line of sight to perimeter vision glazing is counted.

Potential Strategies
Design the space to maximize day lighting and view opportunities. Strategies to consider include lower partitions, interior shading devices, interior glazing and automatic photocell-based controls.

Analysis within the Global Vascular Institute
Due to the nature of the facility, many of the regularly occupied spaces do not have any direct line of sight to the outside of the building. These spaces include mostly operating rooms, labs, and procedure rooms. Because of this, the Global Vascular Institute does not meet the requirements for this credit.

Cost Summary
No additional cost to the project is sustained because this credit is not obtainable.

Additional Thoughts
None

Innovation In Design Credit 1: Innovation in Design (1-5 Points)

Intent

To provide design teams and projects the opportunity to achieve exceptional performance above the requirements set by the LEED Green Building Rating System and/or innovative performance in Green Building categories not specifically addressed by the LEED Green Building Rating System.

Requirements

Credit can be achieved through any combination of the innovation Design and Exemplary Performance paths as described below:

Path 1: Innovation in Design (1-5 Points)

Achieve significant, measureable environmental performance using strategy not addressed in the LEED 2009 for New Construction and Major Renovations Rating System. One point is awarded for each innovation achieved. No more than 5 points under IDc1 may be earned through Path 1 – Innovation in Design. Identify the following in writing:

- The intent of the proposed innovation credit.
- The proposed requirement for compliance.
- The proposed submittals to demonstrate compliance.
- The design approach (strategies) used to meet requirements.

Path 2: Exemplary Performance (1-3 Points)

Achieve exemplary performance in an existing LEED 2009 for New Construction and Major Renovations prerequisite or credit that allows exemplary performance as specified in the LEED Reference Guide for Green Building Design & Construction, 2009 Edition. An exemplary performance may be earned for achieving double the credit requirements and/or achieving the next incremental percentage threshold of an existing credit in LEED. One point is awarded for each exemplary performance achieved. No more than 3 points under IDc1 may be earned through Path 2 – Exemplary Performance.

Potential Strategies

Substantially exceed a LEED 2009 for New Construction and Major Renovations performance credit such as energy performance or water efficiency.

Analysis within the Global Vascular Institute

A detailed analysis was not performed for the Global Vascular Institute because this credit is not specifically defined.

Cost Summary

No cost analysis executed.

Additional Thoughts

None

Innovation In Design Credit 2: LEED Accredited Professional (1 Point)

Intent
To support and encourage the design integration required by LEED to streamline the application and certification process.

Requirements
At least 1 principal participant of the project team shall be a LEED Accredited Professional (AP).

Potential Strategies
Educate the project team members about green building design and construction, the LEED requirements and application process early in the life of the project. Consider assigning integrated design and construction process facilitation to the LEED AP.

Analysis within the Global Vascular Institute
There is a LEED Accredited Professional working on the Global Vascular Institute project so this credit is obtained.

Cost Summary
No additional cost to the project is sustained because a LEED AP was originally assigned to the project.

Additional Thoughts
None

Regional Priority Credit 1: Regional Priority (1-4 Points)

Intent
To provide an incentive for the achievement of credits that address geographically-specific environmental priorities.

Requirements
Earn 1-4 of the 6 Regional Priority credits identified by the USGBC regional councils and chapters as having environmental importance for a project's region. A database of Regional Priority credits and their geographic applicability is available on the USGBC website, http://www.usgbc.org.

One point is awarded for each Regional Priority credit achieved; no more than 4 credits identified as Regional Priority credits may be earned.

Potential Strategies
For the Global Vascular Institute to obtain Regional Priority Credits, the project must meet the required credits. Table 38 below shows which regional priority credits the Global Vascular Institute does and does not meet for Buffalo, NY.

REGIONAL PRIORITY CREDITS	
Credit	**Credit Obtained**
Sustainable Sites Credit 3	0
Sustainable Sites Credit 6.1	1
Sustainable Sites Credit 7.1	1
Sustainable Sites Credit 7.2	1
Energy and Atmosphere Credit 2 (1%)	1
Materials and Resources Credit 1 (75%)	0
Total Credits Earned	**4**

Table 38: Breakdown of the Regional Priority Credits Obtained

Cost Summary
No additional cost to the project is sustained because the cost of these credits is either included the original design of the project or included in other previously obtained credits.

Additional Thoughts
None

7.6 Cost Implications

Table 39 below shows the breakdown of each credit in terms of whether it obtained from the original cost of the building, not obtainable, obtained at no additional cost, obtained at an additional cost, or it was not analyzed.

[blue]	Credit Obtained from Original Design		
[red]	Credit Not Obtainable		
[yellow]	Credit Obtained at No Additional Cost		
[green]	Creddit Obtain at Additional Cost		
[purple]	Credit was Not Analyzed		
Sustainable Sites		**Possible Points: 26**	
Prereq 1	Construction Activity Pollution Prevention	Prerequisite	[blue]
Credit 1	Site Selection	1	[blue]
Credit 2	Development Density and Community Connectivity	5	[blue]
Credit 3	Brownfield Redevelopment	1	[red]
Credit 4.1	Alternative Transportation-Public Transporation Access	6	[blue]
Credit 4.2	Alternative Transportation-Bicycle Storage and Changing Rooms	1	[blue]
Credit 4.3	Alternative Transporation-Low-Emitting and Fuel-Efficient Vehicles	3	[blue]
Credit 4.4	Alternative Transporation-Parking Capacity	2	[blue]
Credit 5.1	Site Development-Protect or Restore Habitat	1	[blue]
Credit 5.2	Site Development-Maximize Open Space	1	[blue]
Credit 6.1	Stormwater Design-Quantity Control	1	[blue]
Credit 6.2	Stormwater Design-Quality Control	1	[green]
Credit 7.1	Heat Island Effect-Non-roof	1	[green]
Credit 7.2	Heat Island Effect-Roof	1	[green]
Credit 8	Light Pollution Reduction	1	[red]
Water Efficiency		**Possible Points: 10**	
Prereq 1	Water Use Reduction-20% Reduction	Prerequisite	[green]
Credit 1	Water Efficient Landscaping	2 to 4	[blue]
Credit 2	Innovative Wastewater Technologies	2	[green]
Credit 3	Water Use Reduction	2 to 4	[green]
Energy and Atmosphere		**Possible Points: 35**	
Prereq 1	Funamental Commissioning of Building Energy Systems	Prerequisite	[blue]
Prereq 2	Minimum Energy Performance	Prerequisite	[blue]
Prereq 3	Funamental Refrigerant Management	Prerequisite	[blue]
Credit 1	Optimize Energy Performance	1 to 19	[blue]
Credit 2	On-Site Renewable Energy	1 to 7	[green]
Credit 3	Enhanced Commissioning	2	[blue]
Credit 4	Enhanced Refrigerant Management	2	[blue]
Credit 5	Measurement and Verification	3	[green]
Credit 6	Green Power	2	[green]

Materials and Resources		**Possible Points: 14**	
Prereq 1	Storage and Collection of Recyclables	Prerequisite	
Credit 1.1	Building Reuse-Maintain Existing Walls, Floors, and Roof	1 to 3	
Credit 1.2	Building Reuse-Maintain 50% of Interior Non-Structural Elements	1	
Credit 2	Construction Waste Management	1 to 2	
Credit 3	Materials Reuse	1 to 2	
Credit 4	Recycled Content	1 to 2	
Credit 5	Regional Materials	1 to 2	
Credit 6	Rapidly Renewable Materials	1	
Credit 7	Certified Wood	1	
Indoor Environmental Quality		**Possible Points: 15**	
Prereq 1	Minimum Indoor Air Quality Performance	Prerequisite	
Prereq 2	Environmental Tobacco Smoke (ETS) Control	Prerequisite	
Credit 1	Outdoor Air Delivery Monitoring	1	
Credit 2	Increased Ventilation	1	
Credit 3.1	Construction IAQ Management Plan-During Construction	1	
Credit 3.2	Construction IAQ Management Plan-Before Occupancy	1	
Credit 4.1	Low-Emitting Materials-Adhesives and Sealants	1	
Credit 4.2	Low-Emitting Materials-Paints and Coatings	1	
Credit 4.3	Low-Emitting Materials-Flooring Systems	1	
Credit 4.4	Low-Emitting Materials-Composite Wood and Agrifiber Products	1	
Credit 5	Indoor Chemical and Pollutant Source Control	1	
Credit 6.1	Controllability of Systems-Lighting	1	
Credit 6.2	Controllability of Systems-Thermal Comfort	1	
Credit 7.1	Thermal Comfort-Design	1	
Credit 7.2	Thermal Comfort-Verification	1	
Credit 8.1	Daylight and Views-Daylight	1	
Credit 8.2	Daylight and Views-Views	1	
Innovation and Design		**Possible Points: 6**	
Credit 1.1	Innovation in Design: Specific Title	1	
Credit 1.2	Innovation in Design: Specific Title	1	
Credit 1.3	Innovation in Design: Specific Title	1	
Credit 1.4	Innovation in Design: Specific Title	1	
Credit 1.5	Innovation in Design: Specific Title	1	
Credit 2	LEED Accredited Professional	1	
Regional Priority Credits		**Possible Points: 4**	
Credit 1.1	Regional Priority: Specific Credit: SSc6.1	1	
Credit 1.2	Regional Priority: Specific Credit: SSc7.1	1	
Credit 1.3	Regional Priority: Specific Credit: SSc7.2	1	
Credit 1.4	Regional Priority: Specific Credit: EAc2	1	

Table 39: Breakdown of Obtainability of LEED Credits

From the point by point analysis, it was determined that the Global Vascular Institute can obtain 46 points from its original design. This would make the project LEED Certified at no additional cost. The highest point total that the Global Vascular Institute can obtain is 72. Since it in not possible to reach a Platinum rating at 80 points, the cost of achieving 60 points for Gold is the highest point total analyzed. It is important to note that the cost of achieving the additional 12 points was not incorporated into the cost because it would not elevate the building to a higher rating. Table 40 shows how much it costs to obtain each of the LEED Ratings for the Global Vascular Institute. This is broken up by each credit category and the overall total. The total cost for each LEED rating includes the soft costs required.

COST FOR ACHIEVING EACH LEED RATING

SUSTAINABLE SITES

LEED Rating	Points from Original Design	Points Obtained at a Cost	Cost of Points	Section Total Points
Original Design	21	-	$ -	21
Certified	21	-	$ -	21
Silver	21	-	$ -	21
Gold	21	-	$ -	21
Platinum	-	-	-	-

WATER EFFICIENCY

LEED Rating	Points from Original Design	Points Obtained at a Cost	Cost of Points	Section Total Points
Original Design	4	-	$ -	4
Certified	4	-	$ -	4
Silver	4	6	$ 39,370	10
Gold	4	6	$ 39,370	10
Platinum	-	-	-	-

ENERGY AND ATMOSPHERE

LEED Rating	Points from Original Design	Points Obtained at a Cost	Cost of Points	Section Total Points
Original Design	5	-	$ -	5
Certified	5	-	$ -	5
Silver	5	2	$ 30,856	7
Gold	5	5	$ 210,856	10
Platinum	-	-	-	-

MATERIALS AND RESOURCES				
LEED Rating	Points from Original Design	Points Obtained at a Cost	Cost of Points	Section Total Points
Original Design	2	-	$ -	2
Certified	2	-	$ -	2
Silver	2	-	$ -	2
Gold	2	3	$ 360,000	5
Platinum	-	-	-	-

INDOOR ENVIRONMENTAL QUALITY				
LEED Rating	Points from Original Design	Points Obtained at a Cost	Cost of Points	Section Total Points
Original Design	12	-	$ -	12
Certified	12	-	$ -	12
Silver	12	-	$ -	12
Gold	12	-	$ -	12
Platinum	-	-	-	-

INNOVATION IN DESIGN				
LEED Rating	Points from Original Design	Points Obtained at a Cost	Cost of Points	Section Total Points
Original Design	1	-	$ -	1
Certified	1	0	$ -	1
Silver	1	0	$ -	1
Gold	1	0	$ -	1
Platinum	-	-	-	-

REGIONAL PRIORITY				
LEED Rating	Points from Original Design	Points Obtained at a Cost	Cost of Points	Section Total Points
Original Design	1	-	$ -	1
Certified	1	-	$ -	1
Silver	1	-	$ -	1
Gold	1	-	$ -	1
Platinum	-	-	-	-

TOTAL				
LEED Rating	Total Additional Cost	% Construction Cost Increase	Point Range	Section Total Points
Original Design	$ -	0%	-	46
Certified	$ -	0%	40-49	46
Silver	$ 3,271,226	1.12%	50-59	54
Gold	$ 3,811,226	1.31%	60-79	60
Platinum	-	-	80-110	-

Table 40: Cost of Achieving Each LEED

Table 41 shows how each of the credits contributes to achieving each rating. Platinum is not included in the table because it is not possible for the Global vascular Institute to obtain a Platinum rating. Credits that were not obtainable, not analyzed, or did not contribute to any LEED ratings, are left blank in the table.

POINTS USED FOR ACHIEVING EACH LEED RATING			Original Building	Certified	Silver	Gold
Sustainable Sites	**Possible Points: 26**					
Prereq 1	Construction Activity Pollution Prevention	Prerequisite				
Credit 1	Site Selection	1				
Credit 2	Development Density and Community Connectivity	5				
Credit 3	Brownfield Redevelopment	1				
Credit 4.1	Alternative Transportation-Public Transporation Access	6				
Credit 4.2	Alternative Transportation-Bicycle Storage and Changing Rooms	1				
Credit 4.3	Alternative Transporation-Low-Emitting and Fuel-Efficient Vehicles	3				
Credit 4.4	Alternative Transporation-Parking Capacity	2				
Credit 5.1	Site Development-Protect or Restore Habitat	1				
Credit 5.2	Site Development-Maximize Open Space	1				
Credit 6.1	Stormwater Design-Quantity Control	1				
Credit 6.2	Stormwater Design-Quality Control	1				
Credit 7.1	Heat Island Effect-Non-roof	1				
Credit 7.2	Heat Island Effect-Roof	1				
Credit 8	Light Pollution Reduction	1				
Water Efficiency	**Possible Points: 10**					
Prereq 1	Water Use Reduction-20% Reduction	Prerequisite				
Credit 1	Water Efficient Landscaping	2 to 4				
Credit 2	Innovative Wastewater Technologies	2				
Credit 3	Water Use Reduction	2 to 4				
Energy and Atmosphere	**Possible Points: 35**					
Prereq 1	Funamental Commissioning of Building Energy Systems	Prerequisite				
Prereq 2	Minimum Energy Performance	Prerequisite				
Prereq 3	Funamental Refrigerant Management	Prerequisite				
Credit 1	Optimize Energy Performance	1 to 19				
Credit 2	On-Site Renewable Energy	1 to 7				
Credit 3	Enhanced Commissioning	2				
Credit 4	Enhanced Refrigerant Management	2				
Credit 5	Measurement and Verification	3				
Credit 6	Green Power	2				

Materials and Resources	**Possible Points: 14**	
Prereq 1	Storage and Collection of Recyclables	Prerequisite
Credit 1.1	Building Reuse-Maintain Existing Walls, Floors, and Roof	1 to 3
Credit 1.2	Building Reuse-Maintain 50% of Interior Non-Structural Elements	1
Credit 2	Construction Waste Management	1 to 2
Credit 3	Materials Reuse	1 to 2
Credit 4	Recycled Content	1 to 2
Credit 5	Regional Materials	1 to 2
Credit 6	Rapidly Renewable Materials	1
Credit 7	Certified Wood	1
Indoor Environmental Quality	**Possible Points: 15**	
Prereq 1	Minimum Indoor Air Quality Performance	Prerequisite
Prereq 2	Environmental Tobacco Smoke (ETS) Control	Prerequisite
Credit 1	Outdoor Air Delivery Monitoring	1
Credit 2	Increased Ventilation	1
Credit 3.1	Construction IAQ Management Plan-During Construction	1
Credit 3.2	Construction IAQ Management Plan-Before Occupancy	1
Credit 4.1	Low-Emitting Materials-Adhesives and Sealants	1
Credit 4.2	Low-Emitting Materials-Paints and Coatings	1
Credit 4.3	Low-Emitting Materials-Flooring Systems	1
Credit 4.4	Low-Emitting Materials-Composite Wood and Agrifiber Products	1
Credit 5	Indoor Chemical and Pollutant Source Control	1
Credit 6.1	Controllability of Systems-Lighting	1
Credit 6.2	Controllability of Systems-Thermal Comfort	1
Credit 7.1	Thermal Comfort-Design	1
Credit 7.2	Thermal Comfort-Verification	1
Credit 8.1	Daylight and Views-Daylight	1
Credit 8.2	Daylight and Views-Views	1
Innovation and Design	**Possible Points: 6**	
Credit 1.1	Innovation in Design: Specific Title	1
Credit 1.2	Innovation in Design: Specific Title	1
Credit 1.3	Innovation in Design: Specific Title	1
Credit 1.4	Innovation in Design: Specific Title	1
Credit 1.5	Innovation in Design: Specific Title	1
Credit 2	LEED Accredited Professional	1
Regional Priority Credits	**Possible Points: 4**	
Credit 1.1	Regional Priority: Specific Credit: SSc6.1	1
Credit 1.2	Regional Priority: Specific Credit: SSc7.1	1
Credit 1.3	Regional Priority: Specific Credit: SSc7.2	1
Credit 1.4	Regional Priority: Specific Credit: EAc2	1

Table 41: Breakdown of Points Used for Achieving Each LEED Rating

7.7 Recommendations and Conclusion

The result of the point-by-point analysis shows that for the Global Vascular Institute to achieve a LEED Certification, only minimal soft costs to the project would be sustained. The original design of the building obtains 46 points. To obtain a higher LEED rating though, additional costs would be necessary. These costs are minimal compared to the overall cost of the project, contributing less than a 2% increase in total construction cost. From the beginning of the project, it was decided not to pursue a LEED rating due to the cost for analyzing and implementing all necessary changes. For the Global Vascular Institute, I would recommend that LEED be implemented into the project since the actual costs are so low compared to the overall cost of the project. It is also recommended that LEED is considered early in the design process so that the necessary requirements can be incorporated in to the original design of the building.

8.0 RECOMMENDATIONS AND CONCLUSIONS

During the last fall and spring semester, the Global Vascular Institute has been analyzed for opportunities to enhance the design of the project to be more efficient and sustainable. This was accomplished by researching and evaluating three main topics: feasibility and design study for photovoltaic energy system, elimination of inefficiency through the use of prefabricated façade panels, and a LEED Certification study.

The first analysis was a feasibility and design study for implementing photovoltaic system on the façade of the building. It was determined that the top half of the South façade was optimal for the photovoltaic array. The system requires 426 panels and produces 115kW of energy which produces a portion of the power the building requires to operate. The system will result in approximately $11,000 of energy savings per year. It was determined that this system would not affect the current structural system of the building. It is recommended that the PV system be connected into the electrical system through the use of two inverters located in the 8th floor electrical room. The overall cost of the project was estimated at approximately $1,150,000, but with the use of rebates and incentives, this was decreased by $432,500. This results in a 9 year payback period for the system if the cost of the original façade is not counted in the cost of the system. Otherwise a 24 year payback period is obtained. It is recommended that the photovoltaic system be pursued given the financial and energy savings for the project.

The second analysis was study on the effects of using prefabrication of the façade to reduce the overall schedule and site congestion for the project. From consultation with a representative from CBO Glass, it was decided that only the East and West façades would benefit the most by using prefabrication. It was determined that there would be an on-site savings of 91 days for the project by using prefabrication. By implementing this though, an additional cost of $357,210 would be incurred on the project. This however is a very minimal cost when comparing it to the overall cost of the project. It was also determined that on-site congestion would also be greatly reduced. The panels would arrive on trucks ready to be installed and require no storage space. It is recommended that the use of prefabrication be pursued given the schedule and site congestion reduction for the project.

The third analysis was a study on the feasibility of obtaining at least a LEED Certification rating for the Global Vascular Institute. After a point-by-point analysis, it was determined that the current design of the project meets the requirements for a LEED Certification rating. From this analysis the cost of obtaining a higher rating was also determined. To obtain silver rating, an additional $3,271,226 is required and for a gold rating an additional $3,811,226 is required.

From the analysis performed, it was found that it is not possible for the Global Vascular Institute to obtain a platinum rating. It is recommended that the study of LEED rating be pursued given the cost required to obtain each rating.

Overall, although the implementation of the three analyses' into the project would require an additional cost to the project, the benefits of greatly weigh this. The benefits include energy savings, schedule and site congestion reduction and recognition as a LEED rated building.

9.0 RESOURCES

Dowling, M (2011, January 26). Turner Construction. (M. Smith, Interviewer)

Google SketchUp 7. (2011). USA: Google

"Incentives/Policies for Renewables & Energy." *Database of State Incentives for Renewables & Efficiency*. N.p., 17 Aug. 2010. Web. 10 Feb. 2011. <http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NY10F&re=1&ee=1>.

Lalonde, C (2011, February 21). Schuco USA. (M. Smith, Interviewer)

National Grid. N.p., n.d. Web. 2 Feb. 2011. <https://www.nationalgridus.com>.

PVWatts: A Performance Calculator for Grid-Connected PV Systems. N.p., n.d. Web. 1 Mar. 2011. <http://rredc.nrel.gov/solar/calculators/PVWATTS/version1/>.

Ryan, J (2011, March 8). CBO Glass. (M. Smith, Interviewer)

R.S. Means Building Construction Cost Data Manual (2011)

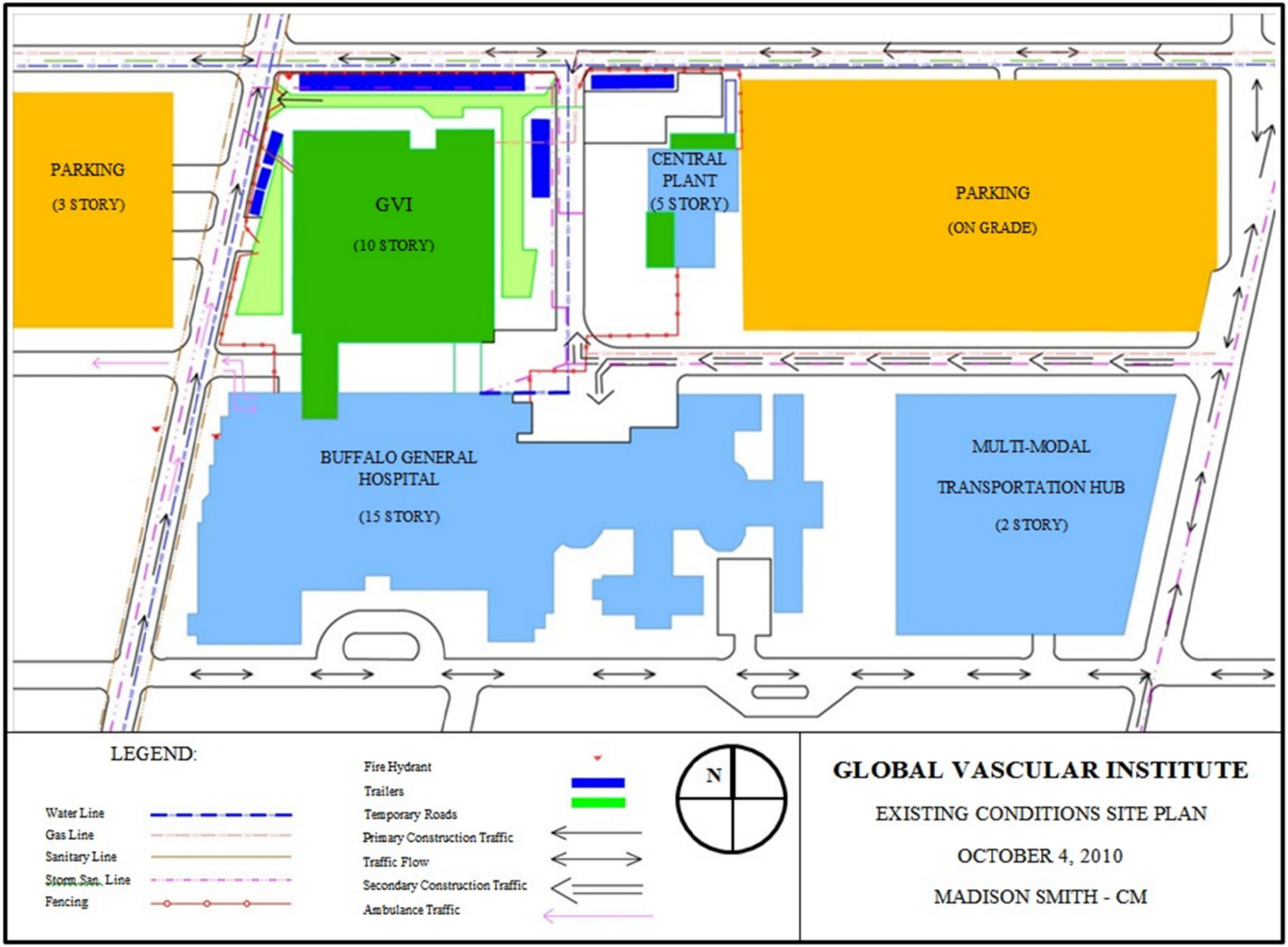
Schuco. N.p., n.d. Web. 27 Jan. 2011. <http://www.schueco.com>.

STAAD.Pro V8i (2008). Exton, PA, USA: Bently Systems, Inc.

Steven Winter Associates. GSA LEED Cost Study. N.p. Oct. 2004. Web. 27 February 2011

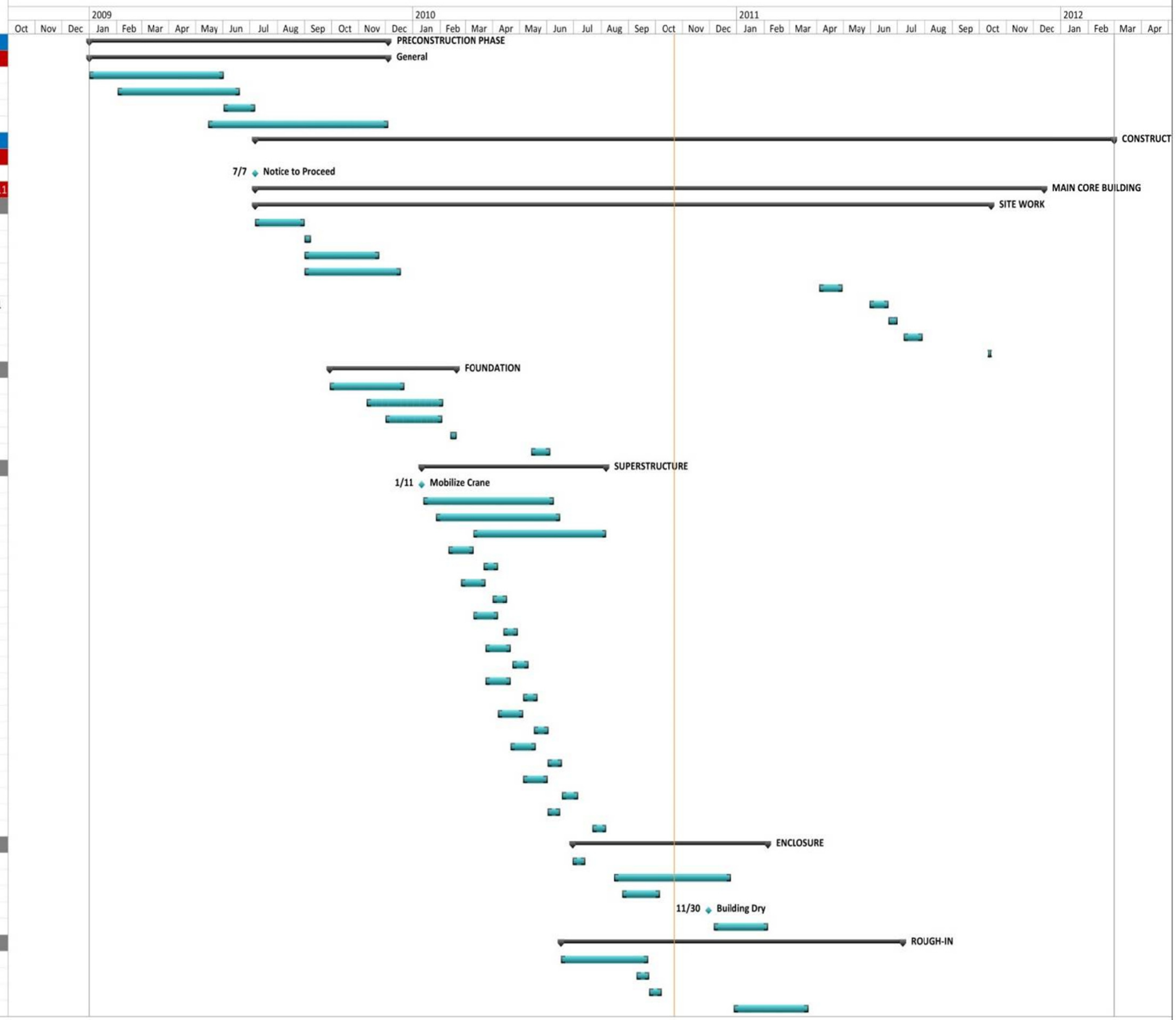
United States Green Building Council. *LEED 2009 For New Construction and Major Renovations*. N.p., 2009. Web. 25 February 2011. <http://www.usgbc.org>.

APPENDIX A – EXISTING CONDITIONS SITE PLAN


PARKING
(3 STORY)
GVI
(10 STORY)
CENTRAL
PLANT
(5 STORY)
PARKING
(ON GRADE)
BUFFALO GENERAL
HOSPITAL
(15 STORY)
MULTI-MODAL
TRANSPORTATION HUB
(2 STORY)
LEGEND:
Water Line
Gas Line
Sanitary Line
Storm San. Line
Fencing
Fire Hydrant
Trailers
Temporary Roads
Primary Construction Traffic
Traffic Flow
Secondary Construction Traffic
Ambulance Traffic
N
GLOBAL VASCULAR INSTITUTE
EXISTING CONDITIONS SITE PLAN
OCTOBER 4, 2010
MADISON SMITH - CM

APPENDIX B - DETAILED PROJECT SCHEDULE

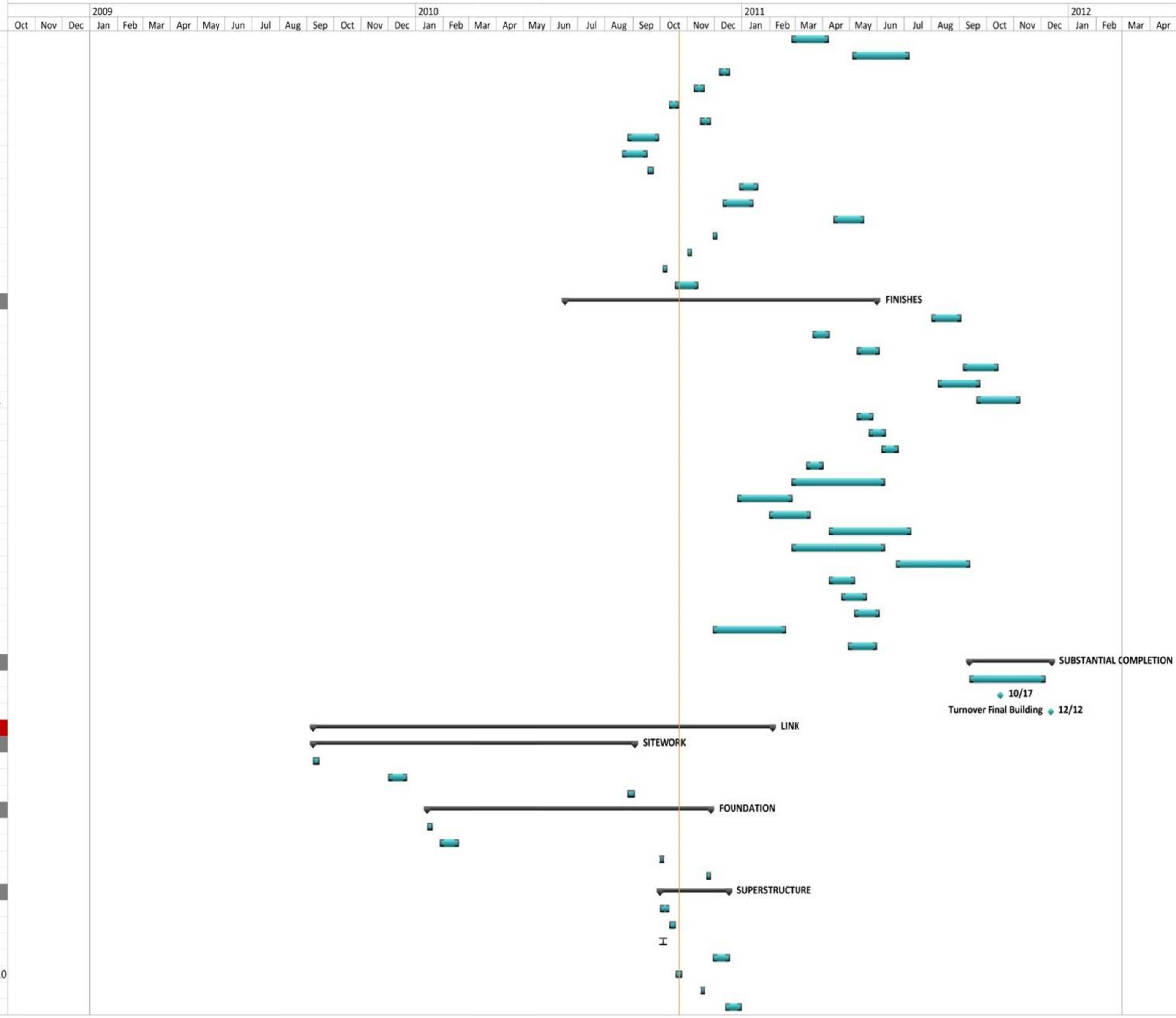
ID	Task Name	Duration	Start	Finish
1	PRECONSTRUCTION PHASE	241 days	Thu 1/1/09	Thu 12/3/09
2	General	241 days	Thu 1/1/09	Thu 12/3/09
3	Design Phase	108 days	Thu 1/1/09	Mon 6/1/09
4	Demolition	100 days	Mon 2/2/09	Fri 6/19/09
5	Permit	25 days	Tue 6/2/09	Mon 7/6/09
6	Bid & Award	145 days	Fri 5/15/09	Thu 12/3/09
7	CONSTRUCTION PHASE	692 days	Tue 7/7/09	Wed 2/29/12
8	GENERAL			
9	Notice to Proceed	0 days	Tue 7/7/09	Tue 7/7/09
10	MAIN CORE BUILDING	635 days	Tue 7/7/09	Mon 12/12/11
11	SITE WORK	594 days	Tue 7/7/09	Fri 10/14/11
12	Mobilization	40 days	Tue 7/7/09	Mon 8/31/09
13	Site Fence	5 days	Tue 9/1/09	Mon 9/7/09
14	Excavation	60 days	Tue 9/1/09	Mon 11/23/09
15	Retaining System	78 days	Tue 9/1/09	Thu 12/17/09
16	Granite Curbs	20 days	Mon 4/4/11	Fri 4/29/11
17	Sidewalks	15 days	Tue 5/31/11	Mon 6/20/11
18	Asphalt Paving Entrance/Parking	8 days	Tue 6/21/11	Thu 6/30/11
19	Curbs	15 days	Fri 7/8/11	Thu 7/28/11
20	Topsoil & Plantings	4 days	Tue 10/11/11	Fri 10/14/11
21	FOUNDATION	103 days	Tue 9/29/09	Thu 2/18/10
22	Piles	60 days	Tue 9/29/09	Mon 12/21/09
23	Foundation Walls	62 days	Tue 11/10/09	Wed 2/3/10
24	Pile Caps and Grade Beams	46 days	Tue 12/1/09	Tue 2/2/10
25	Backfill Foundation Wall	5 days	Fri 2/12/10	Thu 2/18/10
26	Slab-On-Grade	16 days	Fri 5/14/10	Fri 6/4/10
27	SUPERSTRUCTURE	150 days	Mon 1/11/10	Fri 8/6/10
28	Mobilize Crane	0 days	Mon 1/11/10	Mon 1/11/10
29	Structural Steel	105 days	Wed 1/13/10	Tue 6/8/10
30	Steel Decking - Basement	100 days	Wed 1/27/10	Tue 6/15/10
31	Layout/MEP Sleeves, Pour Stops - Basement	108 days	Wed 3/10/10	Fri 8/6/10
32	Steel Decking - 1st Floor	20 days	Wed 2/10/10	Tue 3/9/10
33	Layout/MEP Sleeves, Pour Stops - 1st Level	12 days	Mon 3/22/10	Tue 4/6/10
34	Steel Decking - 2nd Level	20 days	Wed 2/24/10	Tue 3/23/10
35	Layout/MEP Sleeves, Pour Stops - 2nd Level	12 days	Thu 4/1/10	Fri 4/16/10
36	Steel Decking - 3rd Level	20 days	Wed 3/10/10	Tue 4/6/10
37	Layout/MEP Sleeves, Pour Stops - 3rd Level	12 days	Tue 4/13/10	Wed 4/28/10
38	Steel Decking - 4th Level	20 days	Wed 3/24/10	Tue 4/20/10
39	Layout/MEP Sleeves, Pour Stops - 4th Level	12 days	Fri 4/23/10	Mon 5/10/10
40	Steel Decking - 5th Level	20 days	Wed 3/24/10	Tue 4/20/10
41	Layout/MEP Sleeves, Pour Stops - 5th Level	12 days	Wed 5/5/10	Thu 5/20/10
42	Steel Decking - 6th Level	20 days	Wed 4/7/10	Tue 5/4/10
43	Layout/MEP Sleeves, Pour Stops - 6th Level	13 days	Mon 5/17/10	Wed 6/2/10
44	Steel Decking - 7th Level	20 days	Wed 4/21/10	Tue 5/18/10
45	Layout/MEP Sleeves, Pour Stops - 7th Level	12 days	Wed 6/2/10	Thu 6/17/10
46	Steel Decking - 8th Level	20 days	Wed 5/5/10	Tue 6/1/10
47	Layout/MEP Sleeves, Pour Stops - 8th Level	12 days	Fri 6/18/10	Mon 7/5/10
48	Steel Decking - Roof	10 days	Wed 6/2/10	Tue 6/15/10
49	Layout/MEP Sleeves, Pour Stops - Roof	12 days	Thu 7/22/10	Fri 8/6/10
50	ENCLOSURE	158 days	Wed 6/30/10	Fri 2/4/11
51	Roof Deck	10 days	Wed 6/30/10	Tue 7/13/10
52	Curtain Wall Installation	95 days	Mon 8/16/10	Fri 12/24/10
53	Skylights	30 days	Wed 8/25/10	Tue 10/5/10
54	Building Dry	0 days	Tue 11/30/10	Tue 11/30/10
55	Curtain Wall Trim/Finish	45 days	Mon 12/6/10	Fri 2/4/11
56	ROUGH-IN	275 days	Thu 6/17/10	Wed 7/6/11
57	MEP Coordination - Sub-basement	70 days	Thu 6/17/10	Wed 9/22/10
58	MEP Coodination - Basement	10 days	Fri 9/10/10	Thu 9/23/10
59	MEP Coordination - 1st Level	10 days	Fri 9/24/10	Thu 10/7/10
60	MEP Coordination - 2nd Level	60 days	Wed 12/29/10	Tue 3/22/11



Project: Detailed Schedule
Date: Sat 10/23/10

Task		Summary		External Milestone		Inactive Summary		Manual Summary Rollup		Finish-only
Split		Project Summary		Inactive Task		Manual Task		Manual Summary		Deadline
Milestone		External Tasks		Inactive Milestone		Duration-only		Start-only		Progress

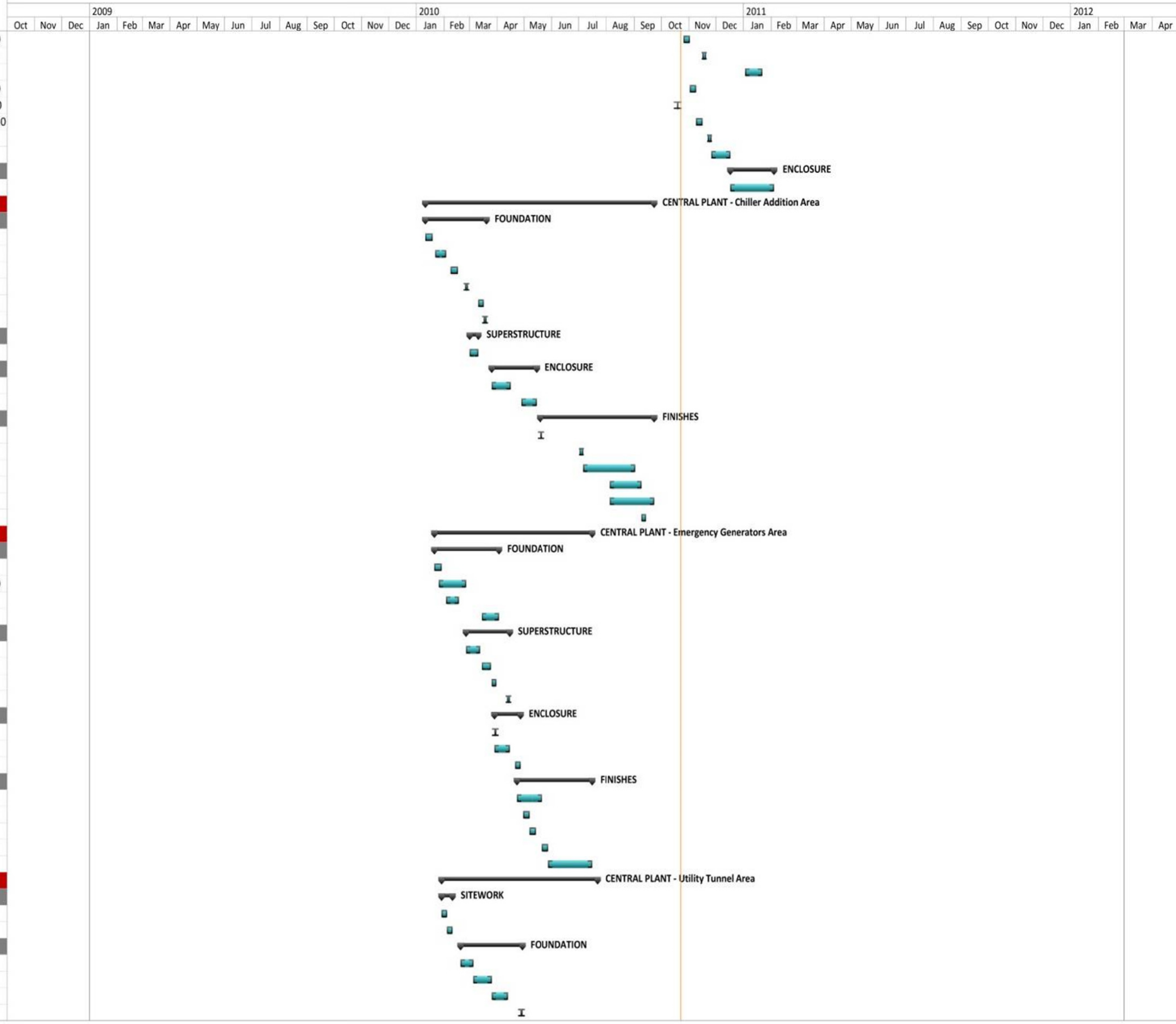
ID	Task Name	Duration	Start	Finish
61	MEP Coordination - 3rd Level	30 days	Fri 2/25/11	Thu 4/7/11
62	MEP Coordination - 4th Level	46 days	Wed 5/4/11	Wed 7/6/11
63	MEP Coordination - 5th Level	10 days	Mon 12/6/10	Fri 12/17/10
64	MEP Coordination - 6th Level	10 days	Mon 11/8/10	Fri 11/19/10
65	MEP Coordination - 7th Level	10 days	Mon 10/11/10	Fri 10/22/10
66	MEP Coordination - 8th Level	10 days	Mon 11/15/10	Fri 11/26/10
67	Metal Stud Installation - Sub-Basement	25 days	Thu 8/26/10	Wed 9/29/10
68	Metal Stud Installation - Basement	20 days	Fri 8/20/10	Thu 9/16/10
69	Metal Stud Installation - 1st Level	5 days	Fri 9/17/10	Thu 9/23/10
70	Metal Stud Installation - 2nd Level	15 days	Wed 12/29/10	Tue 1/18/11
71	Metal Stud Installation - 3rd Level	25 days	Fri 12/10/10	Thu 1/13/11
72	Metal Stud Installation - 4th Level	25 days	Wed 4/13/11	Tue 5/17/11
73	Metal Stud Installation - 5th Level	5 days	Mon 11/29/10	Fri 12/3/10
74	Metal Stud Installation - 6th Level	5 days	Mon 11/1/10	Fri 11/5/10
75	Metal Stud Installation - 7th Level	5 days	Mon 10/4/10	Fri 10/8/10
76	Metal Stud Installation - 8th Level	20 days	Mon 10/18/10	Fri 11/12/10
77	FINISHES	249 days	Thu 6/17/10	Tue 5/31/11
78	MEP Coordination - Sub-basement	25 days	Mon 8/1/11	Fri 9/2/11
79	MEP Coodination - Basement	15 days	Mon 3/21/11	Fri 4/8/11
80	MEP Coordination - 1st Level	20 days	Mon 5/9/11	Fri 6/3/11
81	MEP Coordination - 2nd Level	30 days	Mon 9/5/11	Fri 10/14/11
82	MEP Coordination - 3rd Level	35 days	Mon 8/8/11	Fri 9/23/11
83	MEP Coordination - 4th Level	35 days	Tue 9/20/11	Mon 11/7/11
84	MEP Coordination - 5th Level	15 days	Mon 5/9/11	Fri 5/27/11
85	MEP Coordination - 6th Level	15 days	Mon 5/23/11	Fri 6/10/11
86	MEP Coordination - 7th Level	15 days	Mon 6/6/11	Fri 6/24/11
87	MEP Coordination - 8th Level	15 days	Mon 3/14/11	Fri 4/1/11
88	Drywall Install/Finishing/Paint - Sub-Basement	75 days	Fri 2/25/11	Thu 6/9/11
89	Drywall Install/Finishing/Paint - Basement	45 days	Mon 12/27/10	Fri 2/25/11
90	Drywall Install/Finishing/Paint - 1st Level	35 days	Mon 1/31/11	Fri 3/18/11
91	Drywall Install/Finishing/Paint - 2nd Level	66 days	Fri 4/8/11	Fri 7/8/11
92	Drywall Install/Finishing/Paint - 3rd Level	75 days	Fri 2/25/11	Thu 6/9/11
93	Drywall Install/Finishing/Paint - 4th Level	59 days	Wed 6/22/11	Mon 9/12/11
94	Drywall Install/Finishing/Paint - 5th Level	21 days	Fri 4/8/11	Fri 5/6/11
95	Drywall Install/Finishing/Paint - 6th Level	21 days	Fri 4/22/11	Fri 5/20/11
96	Drywall Install/Finishing/Paint - 7th Level	21 days	Fri 5/6/11	Fri 6/3/11
97	Drywall Install/Finishing/Paint - 8th Level	60 days	Mon 11/29/10	Fri 2/18/11
98	Firestopping	23 days	Fri 4/29/11	Tue 5/31/11
99	SUBSTANTIAL COMPLETION	66 days	Mon 9/12/11	Mon 12/12/11
100	Testing/Balance	61 days	Mon 9/12/11	Mon 12/5/11
101	Turnover to Owner (SB-Level 3)	0 days	Mon 10/17/11	Mon 10/17/11
102	Turnover Final Building	0 days	Mon 12/12/11	Mon 12/12/11
103	LINK	368 days	Tue 9/8/09	Thu 2/3/11
104	SITEWORK	258 days	Tue 9/8/09	Thu 9/2/10
105	Demolition	5 days	Tue 9/8/09	Mon 9/14/09
106	Sanitary and Storm Lines	15 days	Tue 12/1/09	Mon 12/21/09
107	Excavation	6 days	Thu 8/26/10	Thu 9/2/10
108	FOUNDATION	227 days	Thu 1/14/10	Fri 11/26/10
109	Piles	4 days	Thu 1/14/10	Tue 1/19/10
110	Pile Caps and Grade Beams	15 days	Thu 1/28/10	Wed 2/17/10
111	Backfill	2 days	Fri 10/1/10	Mon 10/4/10
112	Concrete Floor - Sub-Basement	5 days	Mon 11/22/10	Fri 11/26/10
113	SUPERSTRUCTURE	55 days	Fri 10/1/10	Thu 12/16/10
114	Erect Steel - Sub-Basement	7 days	Fri 10/1/10	Mon 10/11/10
115	Erect Steel - Basement	5 days	Tue 10/12/10	Mon 10/18/10
116	Steel Decking - Basement	1 day	Mon 10/4/10	Mon 10/4/10
117	Concrete Floor - Basement	15 days	Mon 11/29/10	Fri 12/17/10
118	Erect Steel - 1st Level	5 days	Tue 10/19/10	Mon 10/25/10
119	Steel Decking - 1st Level	4 days	Tue 11/16/10	Fri 11/19/10
120	Concrete Floor - 1st Level	15 days	Mon 12/13/10	Fri 12/31/10



Project: Detailed Schedule
Date: Sat 10/23/10

Task, Split, Milestone, Summary, Project Summary, External Tasks, External Milestone, Inactive Task, Inactive Milestone, Inactive Summary, Manual Task, Duration-only, Manual Summary Rollup, Manual Summary, Start-only, Finish-only, Deadline, Progress

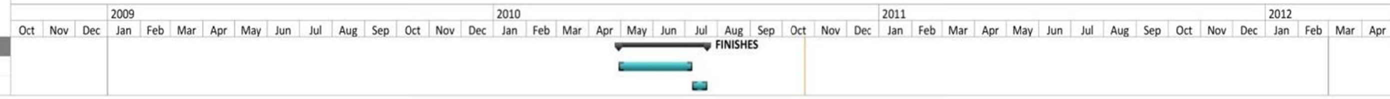
ID	Task Name	Duration	Start	Finish
121	Erect Steel - 2nd Level	5 days	Tue 10/26/10	Mon 11/1/10
122	Steel Decking - 2nd Level	4 days	Tue 11/16/10	Fri 11/19/10
123	Concrete Floor - 2nd Level	15 days	Mon 1/3/11	Fri 1/21/11
124	Erect Steel - 3rd Level	5 days	Tue 11/2/10	Mon 11/8/10
125	Steel Decking - 3rd Level	1 day	Tue 10/19/10	Tue 10/19/10
126	Erect Steel - Roof	5 days	Tue 11/9/10	Mon 11/15/10
127	Steel Decking - Roof	4 days	Mon 11/22/10	Thu 11/25/10
128	Install Roof/Expansion Joint	15 days	Fri 11/26/10	Thu 12/16/10
129	ENCLOSURE	35 days	Fri 12/17/10	Thu 2/3/11
130	Curtainwall	35 days	Fri 12/17/10	Thu 2/3/11
131	CENTRAL PLANT - Chiller Addition Area	183 days	Mon 1/11/10	Wed 9/22/10
132	FOUNDATION	50 days	Mon 1/11/10	Fri 3/19/10
133	Piles	6 days	Mon 1/11/10	Mon 1/18/10
134	Pile Caps and Grade Beams	8 days	Fri 1/22/10	Tue 2/2/10
135	Foundation Walls	6 days	Mon 2/8/10	Mon 2/15/10
136	Backfill	3 days	Wed 2/24/10	Fri 2/26/10
137	Underslab MEP	4 days	Thu 3/11/10	Tue 3/16/10
138	Slab-On-Grade	3 days	Wed 3/17/10	Fri 3/19/10
139	SUPERSTRUCTURE	8 days	Mon 3/1/10	Wed 3/10/10
140	Erect Steel	8 days	Mon 3/1/10	Wed 3/10/10
141	ENCLOSURE	36 days	Fri 3/26/10	Fri 5/14/10
142	Masonry Walls	15 days	Fri 3/26/10	Thu 4/15/10
143	Roofing and Flashing	13 days	Wed 4/28/10	Fri 5/14/10
144	FINISHES	91 days	Wed 5/19/10	Wed 9/22/10
145	Set Cooling Tower	2 days	Wed 5/19/10	Thu 5/20/10
146	Set Chiller	2 days	Fri 7/2/10	Mon 7/5/10
147	Pipe Chiller & Cooling Tower & Tie Ins	42 days	Tue 7/6/10	Wed 9/1/10
148	Chiller Controls	25 days	Thu 8/5/10	Wed 9/8/10
149	Chiller Electrical	35 days	Thu 8/5/10	Wed 9/22/10
150	Chiller Start-Up	3 days	Thu 9/9/10	Mon 9/13/10
151	CENTRAL PLANT - Emergency Generators Area	126 days	Thu 1/21/10	Thu 7/15/10
152	FOUNDATION	52 days	Thu 1/21/10	Fri 4/2/10
153	Piles	6 days	Thu 1/21/10	Thu 1/28/10
154	Pier Caps & Grade Beams & Foundation Walls	22 days	Tue 1/26/10	Wed 2/24/10
155	Underground Electrical	10 days	Wed 2/3/10	Tue 2/16/10
156	Underground Plumbing	15 days	Mon 3/15/10	Fri 4/2/10
157	SUPERSTRUCTURE	35 days	Thu 2/25/10	Wed 4/14/10
158	Erect Steel	12 days	Thu 2/25/10	Fri 3/12/10
159	Joists and Decking	8 days	Mon 3/15/10	Wed 3/24/10
160	Generator Exhaust Stack Curbs/Sleeves	3 days	Fri 3/26/10	Tue 3/30/10
161	Slab-On-Grade	3 days	Mon 4/12/10	Wed 4/14/10
162	ENCLOSURE	21 days	Mon 3/29/10	Mon 4/26/10
163	Exterior Doors/Windows	2 days	Mon 3/29/10	Tue 3/30/10
164	Masonry Walls	13 days	Mon 3/29/10	Wed 4/14/10
165	Roof Decking, Insulation & Roof	4 days	Wed 4/21/10	Mon 4/26/10
166	FINISHES	60 days	Fri 4/23/10	Thu 7/15/10
167	Fuel System Piping	20 days	Fri 4/23/10	Thu 5/20/10
168	Generator Installation	5 days	Fri 4/30/10	Thu 5/6/10
169	Install Fuel Tank	5 days	Fri 5/7/10	Thu 5/13/10
170	Fuel System Controls	5 days	Fri 5/21/10	Thu 5/27/10
171	Controls - Tie Generator into System	35 days	Fri 5/28/10	Thu 7/15/10
172	CENTRAL PLANT - Utility Tunnel Area	124 days	Fri 1/29/10	Wed 7/21/10
173	SITEWORK	8 days	Fri 1/29/10	Tue 2/9/10
174	Existing Structure Investigation	4 days	Fri 1/29/10	Wed 2/3/10
175	Tunnel Excavation	4 days	Thu 2/4/10	Tue 2/9/10
176	FOUNDATION	49 days	Fri 2/19/10	Wed 4/28/10
177	Slab-On-Grade	10 days	Fri 2/19/10	Thu 3/4/10
178	F/P/R Walls	15 days	Fri 3/5/10	Thu 3/25/10
179	F/P/R Ceiling	12 days	Fri 3/26/10	Mon 4/12/10
180	Backfill	2 days	Tue 4/27/10	Wed 4/28/10



Project: Detailed Schedule
Date: Sat 10/23/10

Task | Summary | External Milestone | Inactive Summary | Manual Summary Rollup | Finish-only
Split | Project Summary | Inactive Task | Manual Task | Manual Summary | Deadline
Milestone | External Tasks | Inactive Milestone | Duration-only | Start-only | Progress

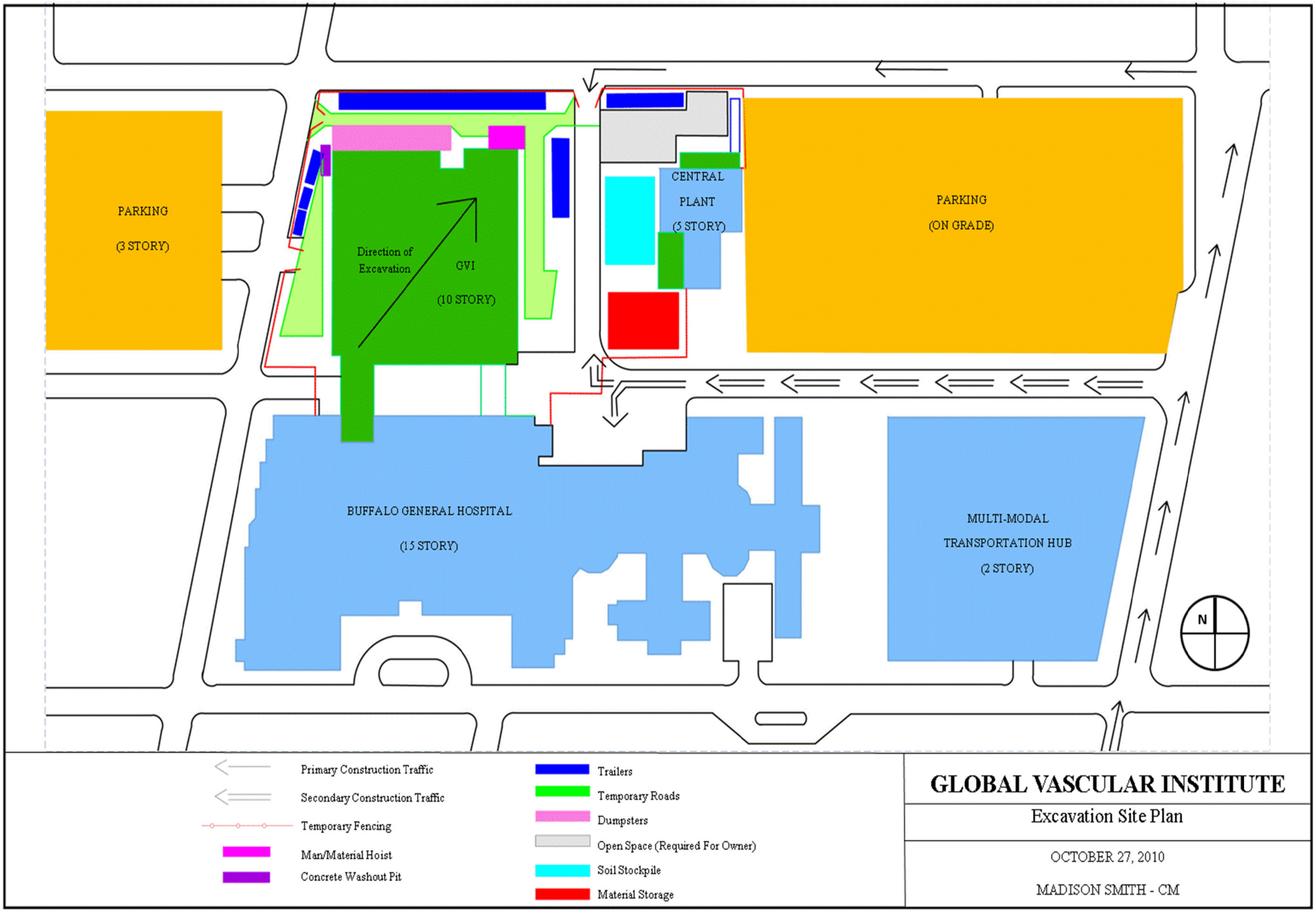
ID	Task Name	Duration	Start	Finish
181	FINISHES	60 days	Thu 4/29/10	Wed 7/21/10
182	Relocate MEP	50 days	Thu 4/29/10	Wed 7/7/10
183	Shutdown/Reconnect MEP Feeds	10 days	Thu 7/8/10	Wed 7/21/10



Project: Detailed Schedule
Date: Sat 10/23/10

Task | Split | Milestone | Summary | Project Summary | External Tasks | External Milestone | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Deadline | Progress

APPENDIX C – SITE LAYOUT PLANS


PARKING
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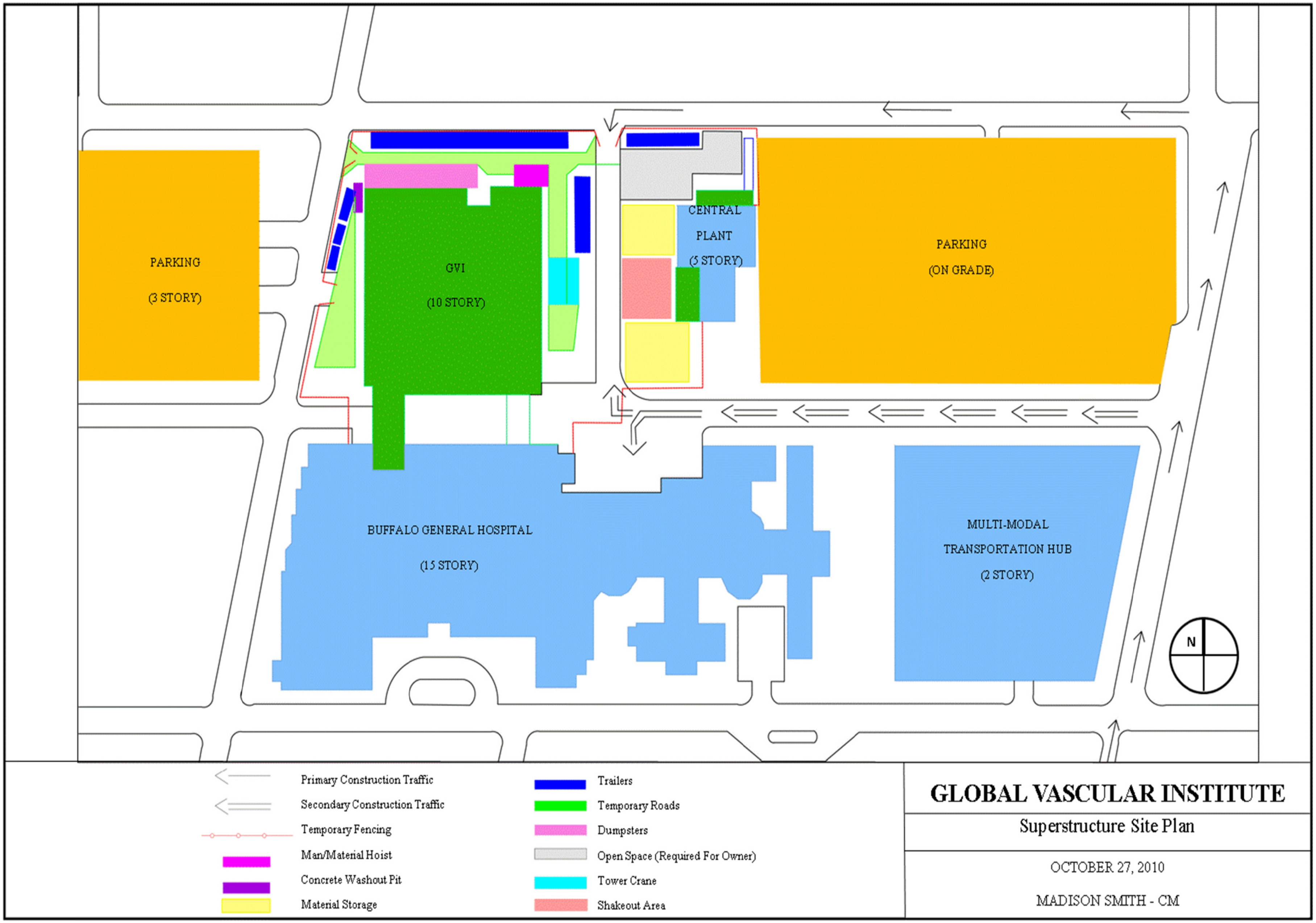
Direction of Excavation
GVI
(10 STORY)
CENTRAL
PLANT
(5 STORY)
PARKING
(ON GRADE)
BUFFALO GENERAL HOSPITAL
(15 STORY)
MULTI-MODAL
TRANSPORTATION HUB
(2 STORY)
N
Primary Construction Traffic
Secondary Construction Traffic
Temporary Fencing
Man/Material Hoist
Concrete Washout Pit
Trailers
Temporary Roads
Dumpsters
Open Space (Required For Owner)
Soil Stockpile
Material Storage
GLOBAL VASCULAR INSTITUTE
Excavation Site Plan
OCTOBER 27, 2010
MADISON SMITH - CM


PARKING
(3 STORY)
GVI
(10 STORY)
CENTRAL
PLANT
(5 STORY)
PARKING
(ON GRADE)
BUFFALO GENERAL HOSPITAL
(15 STORY)
MULTI-MODAL
TRANSPORTATION HUB
(2 STORY)
N
Primary Construction Traffic
Secondary Construction Traffic
Temporary Fencing
Man/Material Hoist
Concrete Washout Pit
Material Storage
Trailers
Temporary Roads
Dumpsters
Open Space (Required For Owner)
Tower Crane
Shakeout Area
GLOBAL VASCULAR INSTITUTE
Superstructure Site Plan
OCTOBER 27, 2010
MADISON SMITH - CM

APPENDIX D – GENERAL CONDITIONS ESTIMATE

GENERAL CONDTIONS ESTIMATE				
ITEM	**UNIT**	**UNIT RATE**	**QUANTITY**	**TOTAL COST**
CONSTRUCTION MANAGER PERSONNEL				
Senior Project Manager	WK	$ 3,000.00	120	$ 360,000.00
Project Manager	WK	$ 2,700.00	120	$ 324,000.00
Project Engineer	WK	$ 1,900.00	108	$ 205,200.00
Assistant Engineer	WK	$ 1,200.00	108	$ 129,600.00
Safety Manager	WK	$ 150.00	108	$ 16,200.00
Senior Superintendent	WK	$ 4,000.00	110	$ 440,000.00
Assistant Superintendent	WK	$ 1,900.00	100	$ 190,000.00
Assistant Superintendent	WK	$ 1,900.00	52	$ 98,800.00
Assistant Superintendent	WK	$ 1,900.00	52	$ 98,800.00
Assistant Superintendent	WK	$ 1,900.00	52	$ 98,800.00
MEP Superintendent	WK	$ 2,200.00	52	$ 114,400.00
Estimating Expenses	LS	$ 43,000.00	1	$ 43,000.00
			TOTAL:	$ 2,118,800.00
TEMPORARY FACILITIES				
Field Office Trailer Set-up	LS	$ 2,200.00	1	$ 2,200.00
Field Office Trailer Rental	MTH	$ 500.00	27	$ 13,500.00
Field Office Trailer Removal	LS	$ 2,400.00	1	$ 2,400.00
Construction Site Fence	MTH	$ 625.00	27	$ 16,875.00
Survey/Layout Equipment	MTH	$ 225.00	27	$ 6,075.00
Gang Box	MTH	$ 55.00	27	$ 1,485.00
Tools/Equipment	MTH	$ 675.00	27	$ 18,225.00
Clean-up Equipment	WK	$ 30.00	96	$ 2,880.00
Fire Extingushers	MTH	$ 80.00	27	$ 2,160.00
Field Copier/Fax/Printer	MTH	$ 400.00	27	$ 10,800.00
Computer/LAN Equipment	MTH	$ 2,500.00	27	$ 67,500.00
Mobile Phones	MTH	$ 350.00	27	$ 9,450.00
Personal Protective Equipment	MTH	$ 100.00	27	$ 2,700.00
Signage	LS	$ 2,700.00	1	$ 2,700.00
Dumpsters	MTH	$ 1,000.00	27	$ 27,000.00
			TOTAL:	$ 185,950.00
TEMPORARY UTILITIES				
Field IT/Network Set-up	LS	$ 4,500.00	1	$ 4,500.00
Field Telephone Hook-up	LS	$ 1,700.00	1	$ 1,700.00
Field Telephone Service	MTH	$ 100.00	27	$ 2,700.00
Temporary Power Installation	LS	$ 14,500.00	1	$ 14,500.00
Temporary Power Consumption	MTH	$ 5,000.00	27	$ 135,000.00
Temporary Water/Sanitary Supply	LS	$ 2,000.00	1	$ 2,000.00
Temporary Toilets	MTH	$ 1,000.00	27	$ 27,000.00
Potable Water	MTH	$ 80.00	27	$ 2,160.00
			TOTAL:	$ 189,560.00
MISCELLANEOUS COSTS				
Progress Photographs	MTH	$ 400.00	27	$ 10,800.00
Document Reproduction	LS	$ 37,000.00	1	$ 37,000.00
Travel Expenses (Staff Vehicles)	MTH	$ 4,000.00	27	$ 108,000.00
Delivery/Shipping Expenses	MTH	$ 350.00	27	$ 9,450.00
Clean-up Expenses	WK	$ 500.00	27	$ 13,500.00
Misc. Field Expenses	MTH	$ 1,000.00	27	$ 27,000.00
			TOTAL:	$ 205,750.00
SUMMARY				
Construction Manager Personnel	MTH	$ 78,474.07	27	$ 2,118,800.00
Temporary Facilities	MTH	$ 6,887.04	27	$ 185,950.00
Temporary Utilities	MTH	$ 7,020.74	27	$ 189,560.00
Miscellaneous Costs	MTH	$ 7,620.37	27	$ 205,750.00
			TOTAL:	$ 2,700,060.00

APPENDIX E - DEFLECTION CHARTS

Original Design Loading

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Job No	Sheet No 1	Rev
Part		
Ref		
By	Date 23-Mar-11	Chd
File Structure3.std	Date/Time 23-Mar-2011 14:50	

Job Title

Client

Beam Maximum Relative Displacements

Distances to maxima are given from beam end A.

Beam	Node A	Length (ft)	L/C	y (in)	d (ft)	z (in)	d (ft)	Resultant (in)	d (ft)	Span Max z
11	11	31.500	1:ALUMINUM	-0.015	15.750	0.000	0.000	0.015	15.750	> 10000
			2:LIVE	0.001	10.500	0.000	0.000	0.001	21.000	> 10000
22	10	31.500	1:ALUMINUM	-0.011	15.750	0.000	0.000	0.011	15.750	> 10000
			2:LIVE	-0.011	15.750	0.000	0.000	0.011	15.750	> 10000
23	9	31.500	1:ALUMINUM	-0.013	15.750	0.000	0.000	0.013	15.750	> 10000
			2:LIVE	-0.012	15.750	0.000	0.000	0.012	15.750	> 10000
24	8	31.500	1:ALUMINUM	-0.011	15.750	0.000	0.000	0.011	15.750	> 10000
			2:LIVE	-0.011	15.750	0.000	0.000	0.011	15.750	> 10000
25	7	31.500	1:ALUMINUM	-0.011	15.750	0.000	0.000	0.011	15.750	> 10000
			2:LIVE	-0.011	15.750	0.000	0.000	0.011	15.750	> 10000
26	6	31.500	1:ALUMINUM	-0.010	15.750	0.000	0.000	0.010	15.750	> 10000
			2:LIVE	-0.010	15.750	0.000	0.000	0.010	15.750	> 10000
27	5	31.500	1:ALUMINUM	-0.009	15.750	0.000	0.000	0.009	15.750	> 10000
			2:LIVE	-0.010	15.750	0.000	0.000	0.010	15.750	> 10000
28	4	31.500	1:ALUMINUM	-0.008	15.750	0.000	0.000	0.008	15.750	> 10000
			2:LIVE	-0.007	15.750	0.000	0.000	0.007	15.750	> 10000
29	3	31.500	1:ALUMINUM	-0.009	15.750	0.000	0.000	0.009	15.750	> 10000
			2:LIVE	-0.009	15.750	0.000	0.000	0.009	15.750	> 10000
30	2	31.500	1:ALUMINUM	-0.005	15.750	0.000	0.000	0.005	15.750	> 10000
			2:LIVE	-0.003	15.750	0.000	0.000	0.003	15.750	> 10000

Print Time/Date: 24/03/2011 13:34 STAAD.Pro V8i (SELECTseries 1) 20.07.06.34 Print Run 1 of 1

PV System Loading

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Job Title	Job No	Sheet No 1	Rev
	Part		
	Ref		
	By	Date 23-Mar-11	Chd
Client	File PV Loading.std	Date/Time 24-Mar-2011 13:19	

Beam Maximum Relative Displacements

Distances to maxima are given from beam end A.

Beam	Node A	Length (ft)	L/C	y (in)	d (ft)	z (in)	d (ft)	Resultant (in)	d (ft)	Span Max z
11	11	31.500	1:PV	-0.013	15.750	0.000	0.000	0.013	15.750	> 10000
			2:LIVE	0.001	10.500	0.000	0.000	0.001	21.000	> 10000
			3:ALUMINUM	0.000	0.000	0.000	0.000	0.000	28.875	
22	10	31.500	1:PV	-0.010	15.750	0.000	0.000	0.010	15.750	> 10000
			2:LIVE	-0.011	15.750	0.000	0.000	0.011	15.750	> 10000
			3:ALUMINUM	0.000	0.000	0.000	0.000	0.000	28.875	
23	9	31.500	1:PV	-0.011	15.750	0.000	0.000	0.011	15.750	> 10000
			2:LIVE	-0.012	15.750	0.000	0.000	0.012	15.750	> 10000
			3:ALUMINUM	0.000	0.000	0.000	0.000	0.000	28.875	
24	8	31.500	1:PV	-0.010	15.750	0.000	0.000	0.010	15.750	> 10000
			2:LIVE	-0.011	15.750	0.000	0.000	0.011	15.750	> 10000
			3:ALUMINUM	0.000	0.000	0.000	0.000	0.000	28.875	
25	7	31.500	1:PV	-0.009	15.750	0.000	0.000	0.009	15.750	> 10000
			2:LIVE	-0.011	15.750	0.000	0.000	0.011	15.750	> 10000
			3:ALUMINUM	0.000	5.250	0.000	0.000	0.000	26.250	> 10000
26	6	31.500	1:PV	-0.007	15.750	0.000	0.000	0.007	15.750	> 10000
			2:LIVE	-0.010	15.750	0.000	0.000	0.010	15.750	> 10000
			3:ALUMINUM	-0.003	15.750	0.000	0.000	0.003	15.750	> 10000
27	5	31.500	1:PV	-0.007	15.750	0.000	0.000	0.007	15.750	> 10000
			2:LIVE	-0.010	15.750	0.000	0.000	0.010	15.750	> 10000
			3:ALUMINUM	-0.003	15.750	0.000	0.000	0.003	15.750	> 10000
28	4	31.500	1:PV	-0.006	15.750	0.000	0.000	0.006	15.750	> 10000
			2:LIVE	-0.007	15.750	0.000	0.000	0.007	15.750	> 10000
			3:ALUMINUM	-0.002	15.750	0.000	0.000	0.002	15.750	> 10000
29	3	31.500	1:PV	-0.006	15.750	0.000	0.000	0.006	15.750	> 10000
			2:LIVE	-0.009	15.750	0.000	0.000	0.009	15.750	> 10000
			3:ALUMINUM	-0.003	15.750	0.000	0.000	0.003	15.750	> 10000
30	2	31.500	1:PV	-0.004	15.750	0.000	0.000	0.004	15.750	> 10000
			2:LIVE	-0.003	15.750	0.000	0.000	0.003	15.750	> 10000
			3:ALUMINUM	-0.001	15.750	0.000	0.000	0.001	15.750	> 10000

Print Time/Date: 24/03/2011 13:35 STAAD.Pro V8i (SELECTseries 1) 20.07.06.34 Print Run 1 of 1

Reduced Beam Size Loading

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Job Title	Job No	Sheet No 1	Rev
	Part		
	Ref		
	By	Date 23-Mar-11	Chd
Client	File PV Reduced size.std	Date/Time 24-Mar-2011 13:29	

Beam Maximum Relative Displacements

Distances to maxima are given from beam end A.

Beam	Node A	Length (ft)	L/C	y (in)	d (ft)	z (in)	d (ft)	Resultant (in)	d (ft)	Span Max z
11	11	31.500	1:PV	-0.015	15.750	0.000	0.000	0.015	15.750	> 10000
			2:LIVE	0.002	15.750	0.000	0.000	0.002	15.750	> 10000
			3:ALUMINUM	0.000	0.000	0.000	0.000	0.000	28.875	
22	10	31.500	1:PV	-0.010	15.750	0.000	0.000	0.010	15.750	> 10000
			2:LIVE	-0.015	15.750	0.000	0.000	0.015	15.750	> 10000
			3:ALUMINUM	0.000	0.000	0.000	0.000	0.000	28.875	
23	9	31.500	1:PV	-0.011	15.750	0.000	0.000	0.011	15.750	> 10000
			2:LIVE	-0.013	15.750	0.000	0.000	0.013	15.750	> 10000
			3:ALUMINUM	0.000	0.000	0.000	0.000	0.000	28.875	
24	8	31.500	1:PV	-0.010	15.750	0.000	0.000	0.010	15.750	> 10000
			2:LIVE	-0.012	15.750	0.000	0.000	0.012	15.750	> 10000
			3:ALUMINUM	0.000	0.000	0.000	0.000	0.000	28.875	
25	7	31.500	1:PV	-0.009	15.750	0.000	0.000	0.009	15.750	> 10000
			2:LIVE	-0.011	15.750	0.000	0.000	0.011	15.750	> 10000
			3:ALUMINUM	0.000	5.250	0.000	0.000	0.000	26.250	> 10000
26	6	31.500	1:PV	-0.007	15.750	0.000	0.000	0.007	15.750	> 10000
			2:LIVE	-0.010	15.750	0.000	0.000	0.010	15.750	> 10000
			3:ALUMINUM	-0.003	15.750	0.000	0.000	0.003	15.750	> 10000
27	5	31.500	1:PV	-0.007	15.750	0.000	0.000	0.007	15.750	> 10000
			2:LIVE	-0.010	15.750	0.000	0.000	0.010	15.750	> 10000
			3:ALUMINUM	-0.003	15.750	0.000	0.000	0.003	15.750	> 10000
28	4	31.500	1:PV	-0.006	15.750	0.000	0.000	0.006	15.750	> 10000
			2:LIVE	-0.007	15.750	0.000	0.000	0.007	15.750	> 10000
			3:ALUMINUM	-0.002	15.750	0.000	0.000	0.002	15.750	> 10000
29	3	31.500	1:PV	-0.006	15.750	0.000	0.000	0.006	15.750	> 10000
			2:LIVE	-0.009	15.750	0.000	0.000	0.009	15.750	> 10000
			3:ALUMINUM	-0.003	15.750	0.000	0.000	0.003	15.750	> 10000
30	2	31.500	1:PV	-0.004	15.750	0.000	0.000	0.004	15.750	> 10000
			2:LIVE	-0.003	15.750	0.000	0.000	0.003	15.750	> 10000
			3:ALUMINUM	-0.001	15.750	0.000	0.000	0.001	15.750	> 10000

Print Time/Date: 24/03/2011 13:36 STAAD.Pro V8i (SELECTseries 1) 20.07.06.34 Print Run 1 of 1

APPENDIX F - INVERTER PRODUCT DATA

Fronius CL 55.5 Delta / 60.0 WYE277

The major advantages of the Fronius CL:

- Unique system design with the Fronius MIX™ concept
- High-yield power electronics
- Intelligent cooling
- Simple planning and easy installation
- Comprehensive system monitoring
- Available in 55.5 kW Delta 208/240V or 60.0 kW WYE277 configurations

Overview

- **Unique system design with the Fronius MIX™ concept.**
  Nine power modules operate in the Fronius CL 36.0 accomplishing something great together. This combination of several power modules has many advantages: maximum earnings in partial load ranges, high system stability, long service life and easy servicing.
- **Highest partial load efficiency.**
  Nine identical power modules divide up the work in the MIX™ concept. The individual power racks are turned off and on automatically depending on the insolation power. This ensures that the load is optimized and yield is always at maximum – even while raining, when cloudy or at dusk.
- **Unsurpassed reliability.**
  The Fronius CL creates a redundant system because it integrates several smaller power modules that work together. If one power module should fail, the others simply take up the slack. In comparison: when the power module fails in monolithic systems, the entire system stops operating and this leads to considerable loss of earnings. The Fronius MIX™ concept ensures that the inverter remains in operation even when there is a defect in a power module and this helps to lock in your earnings.
- **Long service life.**
  The control unit automatically calculates which power racks and how many will be turned on and off in partial load operation using the respective operating hours of the power modules. This helps to equalize the work load on the PC boards. This also decreases the operating hours of the individual power modules thus increasing the service life of the inverter.
- **Fast service option.**
  When service is required, power modules can be removed and replaced easily via the plug & play principle and drawer design. This ensures the highest serviceability and the fastest reaction times on the market.

Technical Data

	Fronius CL 55.5 Delta	Fronius CL 60.0 WYE277
INPUT DATA		
Recommended PV-Power	47.2 - 65.0 kWp	51.0 - 70.2 kWp
MPPT-Voltage Range	230 ... 500 V	230 ... 500 V
Max. Input Voltage (at 1000 W/m² 14°F in open circuit operation)	600 V	600 V
Nominal Input Voltage	390V	390V
Nominal Input Current	151.4A	163.7 A
Max. usable Input Current	256.7 A	277.5 A
DC Startup Voltage	245 V	245 V
Admissible Conductor Size (DC)	350 MCM	350 MCM
No. of DC Input Terminals	2x M12 (1/2") lug per hole	2x M12 (1/2") lug per hole
No. of MPP Trackers	1	1
OUTPUT DATA		
Nominal output power ($P_{AC\ nom}$)	55500 W	60000 W
Max. continuous output power (40°C) 208 V	55500 W	n/a
Max. continuous output power (40°C) 240 V	55500 W	n/a
Max. continuous output power (40°C) 277 V	n/a	60000 W
Nominal AC output voltage	208/240 V	277 V
Operating AC voltage range default 208 V	183-229V	n/a
240 V	211-264V	n/a
277 V	n/a	244-305V

Nominal output current 208 V	92.4A	n/a
240 V	80.1A	n/a
277 V	n/a	43.3A
Number of phases	3	3
Admissible conductor size (AC)	350 MCM	350 MCM
No. of AC Terminals	2X M10 (7/16") lug per hole	2X M10 (7/16") lug per hole
Max. continuous utility backfeed current	0 A	0 A
Nominal output frequency	60 Hz	60 Hz
Operating frequency range	59.3 - 60.5 Hz	59.3 - 60.5 Hz
Total harmonic distortion	< 3 %	< 3 %
Power Factor	1	1
GENERAL DATA		
Max. Efficiency	95.9 %	95.9 %
CEC Efficiency 208 V	94.5 %	n/a
240 V	95.0%	n/a
277 V	n/a	95.5 %
Consumption in standby (night)	< 15 W	< 15 W
Consumption during operation	110 W	110 W
Cooling	Controlled forced ventilation, variable speed fan	Controlled forced ventilation, variable speed fan

Enclosure Type	Type 3R, Powder Coated Aluminum Enclosure (standard)	Type 3R, Powder Coated Aluminum Enclosure (standard)
Unit Dimensions (w/socket) (W x H x D)	43.5 x 76.6 x 31.4 inch	43.5 x 76.6 x 31.4 inch
Inverter Weight (w/socket)	783 lbs	783 lbs
Admissible Ambient Temperature	-13... 122°F	-13 ... 122°F
Rel. Humidity	0 ... 95 % (non-condensing)	0 ... 95 % (non-condensing)
AC- & DC-Disconnects	integrated	integrated
Compliance	UL 1741-2005, IEEE 1547-2003, IEEE 1547.1, ANSI/IEEE C62.41, FCC Part 15 B, NEC Article 690, C22. 2 No. 107.1-01 (September 2001), California Solar Initiative - Program Handbook - Appendix C: Inverter Integral 5 % Meter Performance Specification	UL 1741-2005, IEEE 1547-2003, IEEE 1547.1, ANSI/IEEE C62.41, FCC Part 15 B, NEC Article 690, C22. 2 No. 107.1-01 (September 2001), California Solar Initiative - Program Handbook - Appendix C: Inverter Integral 5 % Meter Performance Specification
PROTECTION DEVICES		
Ground fault protection	internal GFDI (Ground Fault Detector/Interruptor); in accordance with UL 1741-2005 and NEC Art. 690	internal GFDI (Ground Fault Detector/Interrupter); in accordance with UL 1741-2005 and NEC Art. 690
DC reverse polarity protection	internal diode	internal diode
Islanding protection	internal; in accordance with UL 1741-2005, IEEE 1547-2003 and NEC	internal; in accordance with UL 1741-2005, IEEE 1547-2003 and NEC
Over temperature	output power derating/active cooling	output power derating/active cooling

APPENDIX G - FAÇADE PHOTOVOLTAIC SYSTEM PAYBACK PERIOD

Option 1

PAYBACK PERIOD - ADDITIONAL COST TO PROJECT ONLY							
Year	Installation	1	2	3	4	5	6
$/kW Electricity (Assume 5% Inflation)	$ -	$ 0.1477	$ 0.1551	$ 0.1628	$ 0.1710	$ 0.1795	$ 0.1885
Cost	$ 603,100	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ 345,000	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ 87,500	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ -	$ 16,985.50	$ 17,834.78	$ 18,726.51	$ 19,662.84	$ 20,645.98	$ 21,678
Yearly Cash Flow	$ (170,600.00)	$ 16,985.50	$ 17,834.78	$ 18,726.51	$ 19,662.84	$ 20,645.98	$ 21,678
Cumulative Cash Flow	$ (170,600.00)	$(153,614.50)	$ (135,780)	$ (117,053)	$ (97,390)	$ (76,744)	$ (55,066)

Year	7	8	9
$/kW Electricity (Assume 5% Inflation)	$ 0.1979	$ 0.2078	$ 0.2182
Cost	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -
Utility Savings	$ 22,762	$ 23,900	$ 25,095
Yearly Cash Flow	$ 22,762	$ 23,900	$ 25,095
Cumulative Cash Flow	$ (32,304)	$ (8,404)	$ 16,692

Option 2

PAYBACK PERIOD - ENTIRE COST OF PV SYSTEM

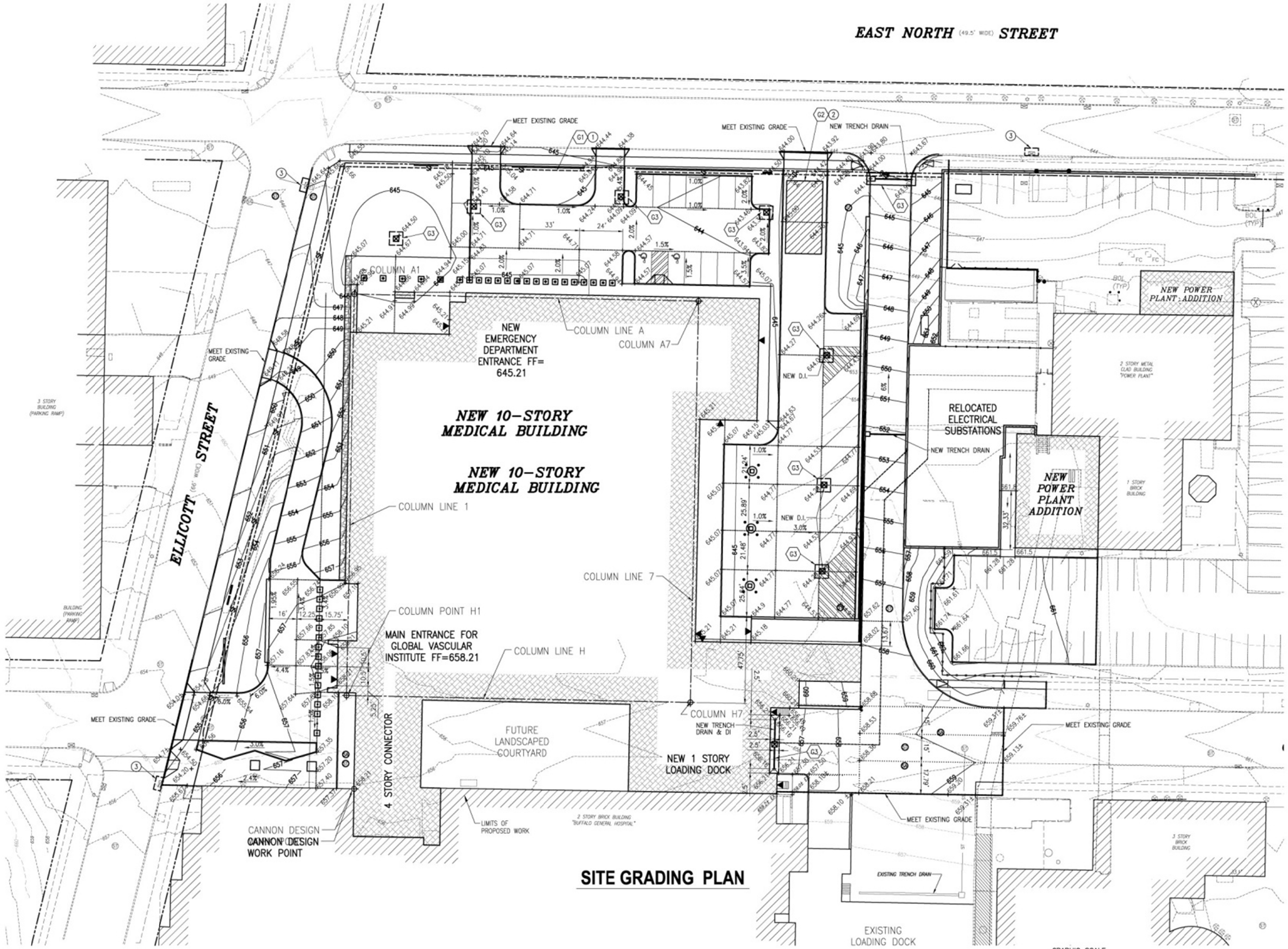
Year	Installation	1	2	3	4	5	6
$/kW Electricity (Assume 5% Inflation)	$ -	$ 0.1477	$ 0.1551	$ 0.1628	$ 0.1710	$ 0.1795	$ 0.1885
Cost	$ 1,150,000	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ 345,000	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ 87,500	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ -	$ 16,986	$ 17,835	$ 18,727	$ 19,663	$ 20,646	$ 21,678
Yearly Cash Flow	$ (717,500)	$ 16,986	$ 17,835	$ 18,727	$ 19,663	$ 20,646	$ 21,678
Cumulative Cash Flow	$ (717,500)	$ (700,515)	$ (682,680)	$ (663,953)	$ (644,290)	$ (623,644)	$ (601,966)

Year	7	8	9	10	11	12	13
$/kW Electricity (Assume 5% Inflation)	$ 0.1979	$ 0.2078	$ 0.2182	$ 0.2291	$ 0.2406	$ 0.2526	$ 0.2652
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ 22,762	$ 23,900	$ 25,095	$ 26,350	$ 27,668	$ 29,051	$ 30,504
Yearly Cash Flow	$ 22,762	$ 23,900	$ 25,095	$ 26,350	$ 27,668	$ 29,051	$ 30,504
Cumulative Cash Flow	$ (579,204)	$ (555,304)	$ (530,208)	$ (503,858)	$ (476,191)	$ (447,140)	$ (416,636)

Year	14	15	16	17	18	19	20
$/kW Electricity (Assume 5% Inflation)	$ 0.2785	$ 0.2924	$ 0.3071	$ 0.3224	$ 0.3385	$ 0.3555	$ 0.3732
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ 32,029	$ 33,630	$ 35,312	$ 37,077	$ 38,931	$ 40,878	$ 42,922
Yearly Cash Flow	$ 32,029	$ 33,630	$ 35,312	$ 37,077	$ 38,931	$ 40,878	$ 42,922
Cumulative Cash Flow	$ (384,607)	$ (350,977)	$ (315,666)	$ (278,588)	$ (239,657)	$ (198,780)	$ (155,858)

Year	21	22	23	24
$/kW Electricity (Assume 5% Inflation)	$ 0.3919	$ 0.4115	$ 0.4321	$ 0.4537
Cost	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -
Utility Savings	$ 45,068	$ 47,321	$ 49,687	$ 52,171
Yearly Cash Flow	$ 45,068	$ 47,321	$ 49,687	$ 52,171
Cumulative Cash Flow	$ (110,791)	$ (63,470)	$ (13,783)	$ 38,389

APPENDIX H - GRADING PLAN



SITE GRADING PLAN

GENERAL SOIL EROSION AND SEDIMENTATION CONTROL NOTES

1. THE CONTRACTOR SHALL COMPLY WITH ALL PROVISIONS OF THE APPLICABLE DEPARTMENT OF ENVIRONMENTAL CONSERVATION WATER QUALITY CERTIFICATION AND/OR FRESHWATER WETLANDS PERMIT.
2. DURING CONSTRUCTION, NO WET OR FRESH CONCRETE OR LEACHATE SHALL BE ALLOWED TO ESCAPE INTO THE WATERS OF NEW YORK STATE, NOR SHALL WASHINGS FROM CONCRETE TRUCKS, MIXERS OR OTHER DEVICES BE ALLOWED TO ENTER ANY WETLAND OR WATERS.
3. ALL STORM INLETS, EXISTING AND PROPOSED SHALL BE PROTECTED DURING CONSTRUCTION AS SHOWN ON THE DETAILS. PROVIDE PIPE INLET/OUTLET PROTECTION AS SHOWN ON PLANS.
4. ALL EXCAVATED MATERIAL SHALL BE PLACED IN THE AREAS DESIGNATED AND BE SUITABLY STABILIZED SO THAT IT CANNOT REASONABLY REENTER ANY WATER BODY OR WETLAND AREA OR SHALL BE PROPERLY DISPOSED OF OFF–SITE.
5. ALL AREAS OF SOIL DISTURBANCE RESULTING FROM THIS PROJECT SHALL BE SODDED. MULCH SHALL BE MAINTAINED UNTIL A SUITABLE VEGETATIVE COVER IS ESTABLISHED.
6. WHERE SILT FENCE IS USED IN AREAS OF CONCENTRATED FLOW, THE ENGINEER MAY CALL FOR BACKING THE FENCE WITH HAY BALES.
7. PERIODIC CLEANING AND INSPECTION OF TEMPORARY SOIL EROSION AND WATER POLLUTION CONTROL DEVICES SHALL BE NECESSARY, A.O.B.E.
8. ALL CONTROLS SHALL BE PLACED PRIOR TO EMBANKMENT OF MATERIALS AND IMMEDIATELY AFTER CONSTRUCTION OF DRAINAGE DITCHES AND SWALES. THE CONTROLS SHALL REMAIN IN PLACE UNTIL THE UNPAVED AREAS ARE STABILIZED WITH SEEDING AND/OR SLOPE PROTECTION, A.O.B.E.
9. FILTER FABRIC SHALL CONFORM TO THE REQUIREMENTS OF SECTION 207–2 OF THE NYSDOT STANDARD SPECIFICATIONS.
10. ADDITIONAL EROSION AND SEDIMENTATION CONTROL MEASURES MAY BE REQUIRED A.O.B.E. SUCH MEASURES SHALL BE IMPLEMENTED AS SPECIFIED IN SECTION 209 OF THE NYSDOT'S SPECIFICATIONS AND AS DETAILED ON 209 SERIES NYSDOT'S STANDARD SHEETS.
11. A STORM WATER POLLUTION PREVENTION PLAN (SWPPP) HAS BEEN PREPARED FOR CONSTRUCTION ACTIVITIES AT THE KALEIDA HEALTH GLOBAL VASCULAR INSTITUTE. THE CONTRACTOR IS REQUIRED TO PROVIDE SOIL EROSION AND SEDIMENTATION CONTROL AT THE SITE AS OUTLINED IN THE SWPPP, AS SHOWN ON THE PROJECT PLANS AND DETAILS AND AS OUTLINED IN THE PROJECT SPECIFICATIONS.

EROSION CONTROL NOTES

(1) INSTALL SILT FENCE ALONG THE PERIMETER OF THE SITE ALONG ELLICOTT ST., EAST NORTH ST. AND NEW ACCESS DRIVE TO PREVENT CONSTRUCTION RUNOFF FROM ENTERING CITY OF BUFFALO SEWERS.

(2) CONTRACTOR TO INSTALL CONSTRUCTION ENTRANCE AS PER DETAILS AT ALL LOCATIONS WHERE CONSTRUCTION VEHICLES WILL ENTER/EXIT THE SITE. LOCATION SHOWN ON PLANS IS FOR ILLUSTRATION PURPOSES ONLY AND MAY BE MOVED BY THE CONTRACTOR BASED ON PROPOSED PHASING PLANS.

(3) CONTRACTOR TO WRAP GRATES OF EXISTING D.I.'S WITHIN ELLICOTT ST. AND NORTH ST. TO PREVENT CONSTRUCTION RUNOFF FROM ENTERING CITY OF BUFFALO SEWERS.

(G1) SILT FENCE DETAIL, SEE DETAIL, DWG. C111

(G2) STABILIZED CONSTRUCTION ENTRANCE DETAIL, SEE DETAIL DWG. C111

(G3) STRAW BALE INLET DETAIL, SEE DETAIL DWG. C111

GRAPHIC SCALE
10 0 10 20 40
(IN FEET)

GRADING LEGEND

- 654 — EXISTING MINOR CONTOURS
- 655 — EXISTING MAJOR CONTOURS
- 654 — PROPOSED MINOR CONTOURS
- 655 — PROPOSED MAJOR CONTOURS

KALEIDA HEALTH
GLOBAL VASCULAR INSTITUTE

University at Buffalo
The State University of New York
CTRC/INCUBATOR

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DiDonato Associates, P.E., P.C.
Civil Engineers
Buffalo, New York

Key Plan

PROJECT NORTH

CONFORMED SET
08 February, 2010

No.	Description	Date

Drawing Title:
SITE GRADING PLAN

Issue Date: 16 November, 2009
Drawn by: Checked by:
Project No.: 002927.00 Scale:
Drawing No.:

C0106

APPENDIX I - STREETBOND SR SLATE PRODUCT DATA

LEED® Green Parking Lot Series

LEED is an internationally recognized **green building** certification system, providing third-party verification that a building or community was designed and built using strategies aimed at improving performance across all the metrics that matter most:

- energy savings
- water efficiency
- CO2 emissions reduction
- improved indoor environmental quality
- stewardship of resources
- sensitivity to their impacts

All the Features and Benefits for the Environment with Specialized Characteristics

StreetBond150™ LEED® green parking lot series contributes to sustainable **green parking lot** design and helps keep them looking new and clean.

Pavement surfaces are a leading cause of **Urban Heat Island Effect** contributing roughly 30-40% of the urban footprint. **Reducing Heat Island Effect** lowers energy consumption and can potentially cut air conditioning bills up to 33%[i]. Not to mention, cooler pavements mean safer more comfortable pavements as well.

Parking lots comprise a large portion of this urban footprint. **StreetBondSR™ – LEED® parking lot series** has specialized solar reflective characteristics that help keep parking lot surfaces cooler and can contribute to **LEED® credits.**

Durable and Value Priced – StreetBondSR™ – LEED® green parking lot series is available in specific colors designed to help keep parking lots looking new, clean and green.

Durable and value priced, StreetBondSR™ – LEED® parking lot series was developed to help reduce parking lot maintenance and cleaning costs. It is available exclusively in specific colors designed to help hide the inevitable soiling and wear & tear parking lots experience, keeping them looking new and clean.

Not Only Sustainable Green Parking Lot – Safer, More Attractive Ones as Well

Create a positive brand experience for your customer from the time they arrive in your **green parking lot** to the time they leave.

StreetBondSR™ – LEED® green parking lot series can contribute LEED® credits under the following categories:

1. **New Construction (NC)** – Sustainable Sites (SSc7.1) – Heat Island Effect – Non-Roof
2. **Existing Building Operations (EBOM)** – Sustainable Sites (SSc7.1) – Heat Island Effect – Non-Roof
3. **Schools – Sustainable Sites (SSc7.1)** – Heat Island Effect – Non-Roof
4. **Green Neighborhood Development** – Green Infrastructure and Buildings – Heat Island Reduction (GIB Credit 9)

One credit can be realized through the use of surface materials which have a Solar Reflectance Index (SRI) of 29 or higher applied to at least 50% of the sites total hardscape including parking lots, roads, sidewalks and courtyards.

APPENDIX J - WATER FIXTURE PRODUCT DATA

Stealth™ 0.8 GPF Ultra High Efficiency Toilet

Stealth™ 0.8 GPF Ultra High Efficiency Toilet

$308.00 (Item # N7716)

Description:

Innovative and stylish, Niagara's 0.8 GPF Stealth™ UHET -- ultra high-efficiency toilet -- goes a step beyond the standard water-saving toilets available on the market. With its low-profile body, breakthrough patented hydraulic technology, and the quietest flush on the planet, Stealth™'s unique design has revolutionized the toilet market.

With its groundbreaking technology, the Stealth™ toilet delivers a powerful, effective, one-time flush. By harnessing the energy created by water filling the tank, this toilet uses a patented air transfer system to pressurize the bowl's trapway. Once activated by simply pressing the flush button, the swift, powerful and quiet flush evacuates all waste in the bowl. Offered in both round front and elongated models and adaptable to fit a standard 12" roughing installation, the Stealth™ easily replaces your existing toilet, lowering water usage and utility bills.

The system is not only capable of functioning efficiently at varying water pressure levels, but it has no expensive parts to replace, further saving the customer money and reducing materials use. Completing its superior engineering, the modern, compact design make it ideal for both new construction and retrofitting projects.

The Stealth™ toilet's water and utility bill savings translate to impressive, real numbers. At a flush rate that saves 37% more water than a standard HET, this WaterSense®-certified toilet saves up to 20,000 gallons and $101 per year* with regular use and up to 200,000 gallons and $1,013 in its lifetime*!

* based on FEMP numbers and a national average water and wastewater combined rate.

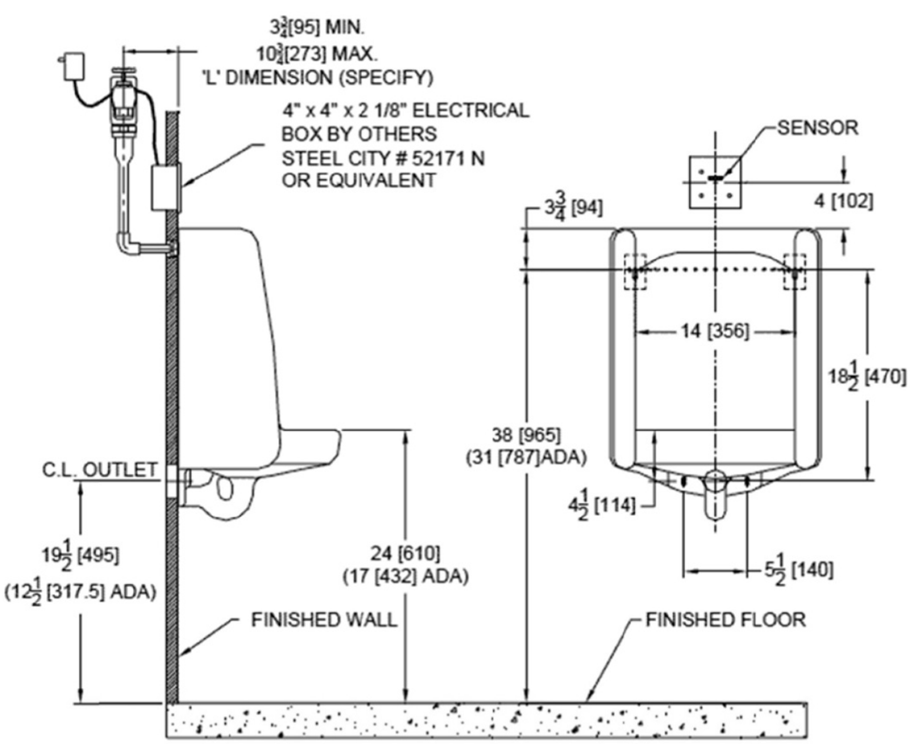
Water Saving, Eco-Friendly Concealed Urinal #Z5799

These high performance, money saving urinals feature:

- Ultra low water consumption - only one pint per flush
- Save money - thousands of dollars over a ten year period
- Over 85% water savings over standard 1.0 gpf
- Includes water saving flush valve
- Sensor flush technology - sanitary handsfree flush
- Sanitary washown and complete trap exchange
- Pressure compensating internal flow regulator
- 3/4" back spud
- Wall hanger mounting brackets included
- Includes 2" IPS outlet flange and rubber gasket with integral trap
- 14" extended rim height for handicap compliance (ADA Compliant) when installed at proper height
- Manual override flush activation button
- Made of high quality durable china
- Includes vandal resistant outlet strainer

Very Low Water Consumption "The Pint" Concealed Urinal = $350.00

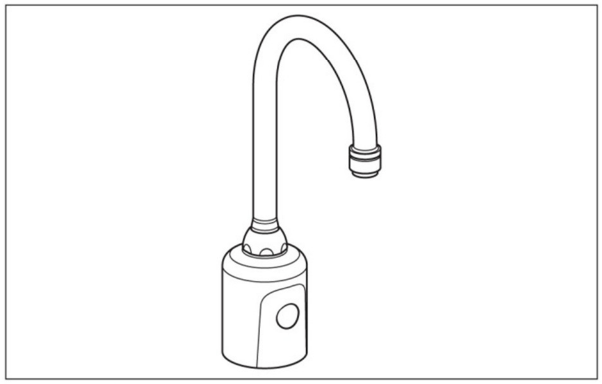
Rough-in dimensions for Z5799 Series



Bradley

S53-326, S53-327
Aerada™ 1000 Series Gooseneck Faucets with Infrared Control

- Reliable Infrared Activation
- Adjustable Operating Modes
- Vandal Resistant
- Above-Deck Water-Tight Electronics
- 6V Lithium Battery Operation (Battery Included)
- 12V AC Transformer Available (Not Included)



Standard Equipment

Infrared Sensor

The IR Sensor uses a twin-beam system to respond quickly when needed, and to elminate false activations. The electronics can be adjusted between static mode sensing the complete IR beam and dynamic mode sensing only hand motion.

Valve

The electronically activated solenoid valve provides reliable performance since there are few moving parts and its operation is unaffected by most chemicals and minerals found in municipal water supplies.

Flow Control/Rate

Operating range 20–80 PSI. The vandal-resistant aerator produces a .5 GPM flow rate. A 2.2 GPM laminar flow insert is optional.

Faucet Body

Single-hole cast brass spout centershank mounting with optional 4" centerset trim plate available.

Sanitary

No-touch operation reduces water/soap splatter and addresses the public's increasing awareness and concern about commnicable diseases.

Vandal Resistant

There are no surface-mounted controls to tempt vandals. The circuit board and range adjustment control are housed in a water-resistant housing above the deck. The sensor will automatically shut off water after 45 seconds (in factory preset mode) if a vandal attempts constant operation.

Code Compliance and Certifications

CSA

The 1000 Series Gooseneck faucets are certified to meet CSA B125 test standards for plumbing fixtures. The faucets are CSA approved in Canada and the United States.

ASME A112.18.1

The 1000 Series Gooseneck Faucets are certified to meet the ASME A112.18.1 standard for plumbing fixtures.

ADA Compliance

The infrared sensor produces a broad detection zone that allows disabled users to easily activate the faucet from either a front or side approach, thereby meeting ADA guidelines provided by ANSI A117-1.

Check Your Surroundings

Certain factors, such as intense direct sunlight, other infrared devices, or other site conditions may interfere with the activation of infrared faucets. Contact your Bradley Representative to discuss any application concerns.

Sample Specification

No-touch infrared faucet shall be (S53-326) Bradley Aerada™ 1000 Series Gooseneck IR Faucet. All Electronics shall be above deck within watertight enclosure. The faucet shall include a chrome-plated, forged brass body with centershank mounting. Faucet shall be certified to CSA standards for both the United States and Canada.

Models

Faucet Only:	
☐ **S53-327**	DC Gooseneck IR Faucet Centershank
☐ **S53-326**	AC Gooseneck IR Faucet Centershank

Optional Selections

Trim Plate:	
☐ **150-221**	4" Chrome-plated trim plate
Transformer:	
☐ **232-008**	Plug-in Transformer 12V
☐ **232-009**	Hardwire Transformer 12V (1–8 Faucets)
Flow Control:	
☐ **269-1923**	2.2 GPM Laminar Flow Control
Water Supply:	
☐ **S59-4004XS**	TMA Vernatherm™ Thermostatic Mixing Valve
☐ **S45-2081**	TL Single Tempered Line w/Stop, Strainer, Check Valves
Temperature Selection Valve:	
☐ **S01-515**	MM2, User-Adjustable Mixing Valve, High Flow 3 GPM
Drain Assembly:	
☐ **269-1231**	D-ASSY, Drain, Strainer, and Tailpiece

This information is subject to change without formal notice.
12/17/2007

P.O. Box 309, Menomonee Falls, WI 53052-0309
Phone: 1-800-BRADLEY Fax: 262-253-4161
www.bradleycorp.com

APPENDIX K - ENERGY ANALYSIS REPORT

LEED 2009 EA Credit 1 Summary Report

General Information

Simulation Program Name and Version .... **Hourly Analysis Program v4.50**
Simulation Weather File Name .... **Buffalo, New York (TM2)**

Building Designations

Proposed Building .... **ALT1 - Sample**
Baseline - 0 degrees .... **ALT2 - BASE**
Baseline - 90 degrees .... **n/a**
Baseline - 180 degrees .... **n/a**
Baseline - 270 degrees .... **n/a**

Floor Areas and Window-to-Wall Ratios

	Proposed Design	Baseline
Total Conditioned Floor Area (ft²)	357,210	357,210
Total Floor Area (ft²)	357,210	357,210
Window to Wall Ratio	55 %	25 %
Gross Wall Area (ft²)	136,080	136,080
Vertical Window Area (ft²)	75,000	34,200

Advisory Messages

	Proposed Building	Baseline Building (0 deg. rotation)	Difference
Number of hours heating loads not met	14	5	+9
Number of hours cooling loads not met	0	0	0

Energy Type Summary

Energy Type	Utility Rate Description	Units of Energy	Units of Demand
Electric	Electric Rate	kWh	kW

Energy Units:
1 kBTU = 1,000 BTU
1 kWh = 3.412 kBTU

Demand Units:
1 MBH = 1,000 BTU/h
1 kW = 3.412 MBH

Baseline Performance - Performance Rating Method Compliance

End Use	Process	Baseline Design Energy Type	Units of Annual Energy & Peak Demand	Baseline (0 deg rotation)	Baseline (90 deg rotation)	Baseline (180 deg rotation)	Baseline (270 deg rotation)	Baseline Design
Interior Lighting	No	Electric	Energy kWh	2,012,971	0	0	0	2,012,971
			Demand kW	578.7	0.0	0.0	0.0	578.7
Space Heating	No	Natural Gas	Energy	3,245,736	0	0	0	3,245,736
			Demand	6,523.8	0.0	0.0	0.0	6,523.8
Space Cooling	No	Electric	Energy kWh	478,497	0	0	0	478,497
			Demand kW	427.3	0.0	0.0	0.0	427.3
Pumps	No	Electric	Energy kWh	205,683	0	0	0	205,683
			Demand kW	83.4	0.0	0.0	0.0	83.4
Heat Rejection	No	Electric	Energy kWh	60,982	0	0	0	60,982
			Demand kW	47.3	0.0	0.0	0.0	47.3
Fans - Interior	No	Electric	Energy kWh	460,263	0	0	0	460,263
			Demand kW	104.6	0.0	0.0	0.0	104.6
Receptacle Equipment	Yes	Electric	Energy kWh	1,901,140	0	0	0	1,901,140
			Demand kW	546.5	0.0	0.0	0.0	546.5

LEED 2009 EA Credit 1 Summary Report

Baseline Energy Totals	Total Annual Energy Use kBTU	20,713,592	0	0	0	17,467,855
	Annual Process Energy kBTU					6,486,688

Baseline Energy Costs

Energy Type	Baseline Cost (0 deg rotation) ($)	Baseline Cost (90 deg rotation) ($)	Baseline Cost (180 deg rotation) ($)	Baseline Cost (270 deg rotation) ($)	Baseline Building Performance ($)
Electric	756,155	0	0	0	756,155
Total Baseline Costs	**756,155**	**0**	**0**	**0**	**756,155**

Performance Rating Table - Performance Rating Method Compliance

End Use	Process	Baseline Building Units	Baseline Building Results	Proposed Design Energy Type	Proposed Design Units	Proposed Building Results	Percent Savings
Interior Lighting	No	Energy kWh	2,012,971	Electric	Energy kWh	1,118,317	44 %
		Demand kW	578.7		Demand kW	321.5	44 %
Space Heating	No	Energy	3,245,736	Natural Gas	Energy	5,230,538	-61 %
		Demand	6,523.8		Demand	8,395.4	-29 %
Space Cooling	No	Energy kWh	478,497	Electric	Energy kWh	583,945	-22 %
		Demand kW	427.3		Demand kW	548.4	-28 %
Pumps	No	Energy kWh	205,683	Electric	Energy kWh	200,061	3 %
		Demand kW	83.4		Demand kW	98.9	-19 %
Heat Rejection	No	Energy kWh	60,982	Electric	Energy kWh	75,819	-24 %
		Demand kW	47.3		Demand kW	55.4	-17 %
Fans - Interior	No	Energy kWh	460,263	Electric	Energy kWh	529,346	-15 %
		Demand kW	104.6		Demand kW	138.0	-32 %
Receptacle Equipment	Yes	Energy kWh	1,901,140	Electric	Energy kWh	1,901,140	0 %
		Demand kW	546.5		Demand kW	546.5	0 %
Energy Totals	Baseline Total Energy Use (kBTU)		17,467,855	Proposed Total Energy Use (kBTU)		20,272,775	-16 %
	Baseline Annual Process Energy (kBTU)		6,486,688	Proposed Annual Process Energy (kBTU)		6,486,688	0 %
	Process Energy Modeling Compliance					Y	

Notes:
(1) Process Energy Costs should be modeled to accurately reflect the proposed building. Process Energy must be the same in the baseline and proposed cases, unless an exceptional calculation is used. Process Energy must be at least 25% of the total Proposed Energy. Any Any exceptions must be supported by a narrative and other supporting documentation.
(2) In this project Process Energy is 32% of total energy for the proposed building.

Energy Cost and Consumption by Energy Type - Performance Rating Method Compliance

	Proposed Design		Baseline Design	
Energy Type	**Energy Use**	**Cost ($)**	**Energy Use**	**Cost ($)**
Electric	4,408,628 kWh	651,154	5,119,536 kWh	756,155
Subtotal (Model Outputs)	**20,272,775 kBTU**	**651,154**	**17,467,855 kBTU**	**756,155**
	Energy Generated	**Renewable Energy Cost Savings ($)**		
Total On Site Renewable Energy				
	Energy Savings	**Cost Savings ($)**		
Exceptional Calculation Totals				
	Energy Use	**Cost ($)**		
Net Proposed Design Total	**20,272,775 kBTU**	**651,154**		
	Percent Savings		**Energy Use Intensity**	
	Energy	**Cost**	**Proposed Design (kBTU/ft²)**	**Baseline Design (kBTU/ft²)**
Summary Data	**-16.1 %**	**13.9 %**	**56.75**	**48.90**

LEED 2009 EA Credit 1 Points Reference Table

New Construction % Cost Savings	Existing Building Renovations % Cost Savings	LEED 2009 Points Awarded
12%	8%	**1 pt**
14%	10%	2 pt
16%	**12%**	**3 pts**
18%	14%	4 pts
20%	16%	5 pts
22%	18%	6 pts
24%	20%	7 pts
26%	22%	8 pts
28%	24%	9 pts
30%	26%	10 pts
32%	28%	11 pts
34%	30%	12 pts
36%	32%	13 pts
38%	34%	14 pts
40%	36%	15 pts
42%	38%	16 pts
44%	40%	17 pts
46%	42%	18 pts
48%	44%	19 pts

APPENDIX L - ROOF PHOTOVOLTAIC SYSTEM PAYBACK PERIOD

1% of ELECTRICITY BY PHOTOVOLTAIC SYSTEM							
Year	Installation	1	2	3	4	5	6
$/kW Electricity (Assume 5% Inflation)	$ -	$ 0.1477	$ 0.1551	$ 0.1628	$ 0.1710	$ 0.1795	$ 0.1885
Cost	$ 444,000	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ 133,200	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ 77,000	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ -	$ 6,498.00	$ 6,823.74	$ 7,164.93	$ 7,523.17	$ 7,899.33	$ 8,294
Yearly Cash Flow	$ (233,800.00)	$ 6,498.00	$ 6,823.74	$ 7,164.93	$ 7,523.17	$ 7,899.33	$ 8,294
Cumulative Cash Flow	$ (233,800.00)	$(227,302.00)	$ (220,478)	$ (213,313)	$ (205,790)	$ (197,891)	$ (189,597)

Year	7	8	9	10	11	12	13
$/kW Electricity (Assume 5% Inflation)	$ 0.1979	$ 0.2078	$ 0.2182	$ 0.2291	$ 0.2406	$ 0.2526	$ 0.2652
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ 8,709	$ 9,144	$ 9,602	$ 10,082	$ 10,586	$ 11,115	$ 11,671
Yearly Cash Flow	$ 8,709	$ 9,144	$ 9,602	$ 10,082	$ 10,586	$ 11,115	$ 11,671
Cumulative Cash Flow	$ (180,888)	$ (171,743)	$ (162,141)	$ (152,060)	$ (141,474)	$ (130,359)	$ (118,688)

Year	14	15	16	17	18	19	20
$/kW Electricity (Assume 5% Inflation)	$ 0.2785	$ 0.2924	$ 0.3071	$ 0.3224	$ 0.3385	$ 0.3555	$ 0.3732
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ 12,254	$ 12,867	$ 13,511	$ 14,186	$ 14,895	$ 15,640	$ 16,422
Yearly Cash Flow	$ 12,254	$ 12,867	$ 13,511	$ 14,186	$ 14,895	$ 15,640	$ 16,422
Cumulative Cash Flow	$ (106,433)	$ (93,566)	$ (80,055)	$ (65,869)	$ (50,974)	$ (35,334)	$ (18,912)

Year	21	22
$/kW Electricity (Assume 5% Inflation)	$ 0.3919	$ 0.4115
Cost	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -
Utility Savings	$ 17,243	$ 18,105
Yearly Cash Flow	$ 17,243	$ 18,105
Cumulative Cash Flow	$ (1,669)	$ 16,437

3% of ELECTRICITY BY PHOTOVOLTAIC SYSTEM							
Year	Installation	1	2	3	4	5	6
$/kW Electricity (Assume 5% Inflation)	$ -	$ 0.1477	$ 0.1551	$ 0.1628	$ 0.1710	$ 0.1795	$ 0.1885
Cost	$ 1,320,000	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ 396,000	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ 87,500	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ -	$ 19,496	$ 20,471	$ 21,495	$ 22,570	$ 23,698	$ 24,883
Yearly Cash Flow	$ (836,500)	$ 19,496	$ 20,471	$ 21,495	$ 22,570	$ 23,698	$ 24,883
Cumulative Cash Flow	$ (836,500)	$ (817,004)	$ (796,532)	$ (775,038)	$ (752,468)	$ (728,770)	$ (703,887)

Year	7	8	9	10	11	12	13
$/kW Electricity (Assume 5% Inflation)	$ 0.1979	$ 0.2078	$ 0.2182	$ 0.2291	$ 0.2406	$ 0.2526	$ 0.2652
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ 26,127	$ 27,433	$ 28,805	$ 30,245	$ 31,758	$ 33,345	$ 35,013
Yearly Cash Flow	$ 26,127	$ 27,433	$ 28,805	$ 30,245	$ 31,758	$ 33,345	$ 35,013
Cumulative Cash Flow	$ (677,760)	$ (650,327)	$ (621,522)	$ (591,276)	$ (559,519)	$ (526,173)	$ (491,161)

Year	14	15	16	17	18	19	20
$/kW Electricity (Assume 5% Inflation)	$ 0.2785	$ 0.2924	$ 0.3071	$ 0.3224	$ 0.3385	$ 0.3555	$ 0.3732
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ 36,763	$ 38,602	$ 40,532	$ 42,558	$ 44,686	$ 46,920	$ 49,266
Yearly Cash Flow	$ 36,763	$ 38,602	$ 40,532	$ 42,558	$ 44,686	$ 46,920	$ 49,266
Cumulative Cash Flow	$ (454,397)	$ (415,796)	$ (375,264)	$ (332,706)	$ (288,020)	$ (241,099)	$ (191,833)

Year	21	22	23	24
$/kW Electricity (Assume 5% Inflation)	$ 0.3919	$ 0.4115	$ 0.4321	$ 0.4537
Cost	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -
Utility Savings	$ 51,730	$ 54,316	$ 57,032	$ 59,884
Yearly Cash Flow	$ 51,730	$ 54,316	$ 57,032	$ 59,884
Cumulative Cash Flow	$ (140,103)	$ (85,787)	$ (28,755)	$ 31,129

5% of ELECTRICITY BY PHOTOVOLTAIC SYSTEM							
Year	Installation	1	2	3	4	5	6
$/kW Electricity (Assume 5% Inflation)	$ -	$ 0.1477	$ 0.1551	$ 0.1628	$ 0.1710	$ 0.1795	$ 0.1885
Cost	$ 2,200,000	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ 660,000	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ 87,500	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ -	$ 32,494	$ 34,119	$ 35,825	$ 37,616	$ 39,497	$ 41,471
Yearly Cash Flow	$ (1,452,500)	$ 32,494	$ 34,119	$ 35,825	$ 37,616	$ 39,497	$ 41,471
Cumulative Cash Flow	$ (1,452,500)	$ (1,420,006)	$(1,385,887)	$(1,350,063)	$(1,312,447)	$(1,272,950)	$(1,231,479)

Year	7	8	9	10	11	12	13
$/kW Electricity (Assume 5% Inflation)	$ 0.1979	$ 0.2078	$ 0.2182	$ 0.2291	$ 0.2406	$ 0.2526	$ 0.2652
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ 43,545	$ 45,722	$ 48,008	$ 50,409	$ 52,929	$ 55,576	$ 58,355
Yearly Cash Flow	$ 43,545	$ 45,722	$ 48,008	$ 50,409	$ 52,929	$ 55,576	$ 58,355
Cumulative Cash Flow	$ (1,187,934)	$ (1,142,211)	$(1,094,203)	$(1,043,794)	$ (990,865)	$ (935,289)	$ (876,934)

Year	14	15	16	17	18	19	20
$/kW Electricity (Assume 5% Inflation)	$ 0.2759	$ 0.2897	$ 0.3041	$ 0.3193	$ 0.3353	$ 0.3521	$ 0.3697
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ 60,689	$ 63,723	$ 66,909	$ 70,255	$ 73,768	$ 77,456	$ 81,329
Yearly Cash Flow	$ 60,689	$ 63,723	$ 66,909	$ 70,255	$ 73,768	$ 77,456	$ 81,329
Cumulative Cash Flow	$ (816,246)	$ (752,522)	$ (685,613)	$ (615,358)	$ (541,591)	$ (464,135)	$ (382,806)

Year	21	22	23	24	25
$/kW Electricity (Assume 5% Inflation)	$ 0.3882	$ 0.4076	$ 0.4279	$ 0.4493	$ 0.4718
Cost	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ 85,395	$ 89,665	$ 94,148	$ 98,856	$ 103,798
Yearly Cash Flow	$ 85,395	$ 89,665	$ 94,148	$ 98,856	$ 103,798
Cumulative Cash Flow	$ (297,411)	$ (207,746)	$ (113,598)	$ (14,742)	$ 89,056

7% of ELECTRICITY BY PHOTOVOLTAIC SYSTEM

Year	Installation	1	2	3	4	5	6
$/kW Electricity (Assume 4% Inflation)	$ -	$ 0.1477	$ 0.1551	$ 0.1628	$ 0.1710	$ 0.1795	$ 0.1885
Cost	$ 3,090,000	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ 927,000	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ 87,500	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ -	$ 45,639	$ 47,921	$ 50,317	$ 52,833	$ 55,475	$ 58,249
Yearly Cash Flow	$ (2,075,500)	$ 45,639	$ 47,921	$ 50,317	$ 52,833	$ 55,475	$ 58,249
Cumulative Cash Flow	$ (2,075,500)	$ (2,029,861)	$(1,981,939)	$(1,931,622)	$(1,878,789)	$(1,823,314)	$(1,765,065)

Year	7	8	9	10	11	12	13
$/kW Electricity (Assume 4% Inflation)	$ 0.1979	$ 0.2078	$ 0.2182	$ 0.2291	$ 0.2406	$ 0.2526	$ 0.2652
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ 61,161	$ 64,219	$ 67,430	$ 70,802	$ 74,342	$ 78,059	$ 81,962
Yearly Cash Flow	$ 61,161	$ 64,219	$ 67,430	$ 70,802	$ 74,342	$ 78,059	$ 81,962
Cumulative Cash Flow	$ (1,703,904)	$ (1,639,685)	$(1,572,255)	$(1,501,454)	$(1,427,112)	$(1,349,053)	$(1,267,092)

Year	14	15	16	17	18	19	20
$/kW Electricity (Assume 4% Inflation)	$ 0.2785	$ 0.2924	$ 0.3071	$ 0.3224	$ 0.3385	$ 0.3555	$ 0.3732
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ 86,060	$ 90,363	$ 94,881	$ 99,625	$ 104,606	$ 109,836	$ 115,328
Yearly Cash Flow	$ 86,060	$ 90,363	$ 94,881	$ 99,625	$ 104,606	$ 109,836	$ 115,328
Cumulative Cash Flow	$ (1,181,032)	$ (1,090,669)	$ (995,789)	$ (896,164)	$ (791,558)	$ (681,721)	$ (566,393)

Year	21	22	23	24	25
$/kW Electricity (Assume 5% Inflation)	$ 0.3919	$ 0.4115	$ 0.4321	$ 0.4537	$ 0.4763
Cost	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ 121,095	$ 127,149	$ 133,507	$ 140,182	$ 147,191
Yearly Cash Flow	$ 121,095	$ 127,149	$ 133,507	$ 140,182	$ 147,191
Cumulative Cash Flow	$ (445,298)	$ (318,149)	$ (184,642)	$ (44,460)	$ 102,731

9% of ELECTRICITY BY PHOTOVOLTAIC SYSTEM							
Year	Installation	1	2	3	4	5	6
$/kW Electricity (Assume 5% Inflation)	$ -	$ 0.1477	$ 0.1551	$ 0.1628	$ 0.1710	$ 0.1795	$ 0.1885
Cost	$ 3,970,000	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ 1,191,000	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ 87,500	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ -	$ 58,637	$ 61,569	$ 64,647	$ 67,880	$ 71,274	$ 74,837
Yearly Cash Flow	$ (2,691,500)	$ 58,637	$ 61,569	$ 64,647	$ 67,880	$ 71,274	$ 74,837
Cumulative Cash Flow	$ (2,691,500)	$ (2,632,863)	$(2,571,294)	$(2,506,647)	$(2,438,768)	$(2,367,494)	$(2,292,657)

Year	7	8	9	10	11	12	13
$/kW Electricity (Assume 5% Inflation)	$ 0.1979	$ 0.2078	$ 0.2182	$ 0.2291	$ 0.2406	$ 0.2526	$ 0.2652
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ 78,579	$ 82,508	$ 86,633	$ 90,965	$ 95,513	$ 100,289	$ 105,303
Yearly Cash Flow	$ 78,579	$ 82,508	$ 86,633	$ 90,965	$ 95,513	$ 100,289	$ 105,303
Cumulative Cash Flow	$ (2,214,078)	$ (2,131,570)	$(2,044,936)	$(1,953,971)	$(1,858,458)	$(1,758,169)	$(1,652,866)

Year	14	15	16	17	18	19	20
$/kW Electricity (Assume 5% Inflation)	$ 0.2785	$ 0.2924	$ 0.3071	$ 0.3224	$ 0.3385	$ 0.3555	$ 0.3732
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ 110,569	$ 116,097	$ 121,902	$ 127,997	$ 134,397	$ 141,117	$ 148,173
Yearly Cash Flow	$ 110,569	$ 116,097	$ 121,902	$ 127,997	$ 134,397	$ 141,117	$ 148,173
Cumulative Cash Flow	$ (1,542,297)	$ (1,426,200)	$(1,304,298)	$(1,176,301)	$(1,041,904)	$ (900,787)	$ (752,615)

Year	21	22	23	24	25
$/kW Electricity (Assume 5% Inflation)	$ 0.3919	$ 0.4115	$ 0.4321	$ 0.4537	$ 0.4763
Cost	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ 155,581	$ 163,360	$ 171,528	$ 180,105	$ 189,110
Yearly Cash Flow	$ 155,581	$ 163,360	$ 171,528	$ 180,105	$ 189,110
Cumulative Cash Flow	$ (597,034)	$ (433,674)	$ (262,145)	$ (82,041)	$ 107,069

11% of ELECTRICITY BY PHOTOVOLTAIC SYSTEM							
Year	Installation	1	2	3	4	5	6
$/kW Electricity (Assume 5% Inflation)	$ -	$ 0.1477	$ 0.1551	$ 0.1628	$ 0.1710	$ 0.1795	$ 0.1885
Cost	$ 4,850,000	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ 1,455,000	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ 87,500	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ -	$ 71,635	$ 75,216	$ 78,977	$ 82,926	$ 87,072	$ 91,426
Yearly Cash Flow	$ (3,307,500)	$ 71,635	$ 75,216	$ 78,977	$ 82,926	$ 87,072	$ 91,426
Cumulative Cash Flow	$ (3,307,500)	$ (3,235,866)	$(3,160,649)	$(3,081,672)	$(2,998,746)	$(2,911,674)	$(2,820,248)

Year	7	8	9	10	11	12	13
$/kW Electricity (Assume 5% Inflation)	$ 0.1979	$ 0.2078	$ 0.2182	$ 0.2291	$ 0.2406	$ 0.2526	$ 0.2652
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ 95,997	$ 100,797	$ 105,837	$ 111,129	$ 116,685	$ 122,519	$ 128,645
Yearly Cash Flow	$ 95,997	$ 100,797	$ 105,837	$ 111,129	$ 116,685	$ 122,519	$ 128,645
Cumulative Cash Flow	$ (2,724,251)	$ (2,623,454)	$(2,517,618)	$(2,406,489)	$(2,289,804)	$(2,167,285)	$(2,038,639)

Year	14	15	16	17	18	19	20
$/kW Electricity (Assume 5% Inflation)	$ 0.2785	$ 0.2924	$ 0.3071	$ 0.3224	$ 0.3385	$ 0.3555	$ 0.3732
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ 135,078	$ 141,831	$ 148,923	$ 156,369	$ 164,188	$ 172,397	$ 181,017
Yearly Cash Flow	$ 135,078	$ 141,831	$ 148,923	$ 156,369	$ 164,188	$ 172,397	$ 181,017
Cumulative Cash Flow	$ (1,903,562)	$ (1,761,730)	$(1,612,807)	$(1,456,438)	$(1,292,251)	$(1,119,854)	$ (938,837)

Year	21	22	23	24	25
$/kW Electricity (Assume 5% Inflation)	$ 0.3919	$ 0.4115	$ 0.4321	$ 0.4537	$ 0.4763
Cost	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ 190,068	$ 199,571	$ 209,550	$ 220,027	$ 231,028
Yearly Cash Flow	$ 190,068	$ 199,571	$ 209,550	$ 220,027	$ 231,028
Cumulative Cash Flow	$ (748,769)	$ (549,198)	$ (339,649)	$ (119,622)	$ 111,407

13% of ELECTRICITY BY PHOTOVOLTAIC SYSTEM							
Year	Installation	1	2	3	4	5	6
$/kW Electricity (Assume 5% Inflation)	$ -	$ 0.1477	$ 0.1551	$ 0.1628	$ 0.1710	$ 0.1795	$ 0.1885
Cost	$ 5,730,000	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ 1,719,000	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ 87,500	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ -	$ 84,632	$ 88,864	$ 93,307	$ 97,972	$ 102,871	$ 108,014
Yearly Cash Flow	$ (3,923,500)	$ 84,632	$ 88,864	$ 93,307	$ 97,972	$ 102,871	$ 108,014
Cumulative Cash Flow	$ (3,923,500)	$ (3,838,868)	$(3,750,004)	$(3,656,697)	$(3,558,725)	$(3,455,854)	$(3,347,840)

Year	7	8	9	10	11	12	13
$/kW Electricity (Assume 5% Inflation)	$ 0.1979	$ 0.2078	$ 0.2182	$ 0.2291	$ 0.2406	$ 0.2526	$ 0.2652
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ 113,415	$ 119,086	$ 125,040	$ 131,292	$ 137,857	$ 144,750	$ 151,987
Yearly Cash Flow	$ 113,415	$ 119,086	$ 125,040	$ 131,292	$ 137,857	$ 144,750	$ 151,987
Cumulative Cash Flow	$ (3,234,425)	$ (3,115,339)	$(2,990,299)	$(2,859,007)	$(2,721,150)	$(2,576,400)	$(2,424,413)

Year	14	15	16	17	18	19	20
$/kW Electricity (Assume 5% Inflation)	$ 0.2785	$ 0.2924	$ 0.3071	$ 0.3224	$ 0.3385	$ 0.3555	$ 0.3732
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ 159,586	$ 167,566	$ 175,944	$ 184,741	$ 193,978	$ 203,677	$ 213,861
Yearly Cash Flow	$ 159,586	$ 167,566	$ 175,944	$ 184,741	$ 193,978	$ 203,677	$ 213,861
Cumulative Cash Flow	$ (2,264,827)	$ (2,097,261)	$(1,921,317)	$(1,736,576)	$(1,542,597)	$(1,338,920)	$(1,125,059)

Year	21	22	23	24	25
$/kW Electricity (Assume 5% Inflation)	$ 0.3919	$ 0.4115	$ 0.4321	$ 0.4537	$ 0.4763
Cost	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Cost)	$ -	$ -	$ -	$ -	$ -
New York State Incentive ($1.75/W)	$ -	$ -	$ -	$ -	$ -
Utility Savings	$ 224,554	$ 235,782	$ 247,571	$ 259,950	$ 272,947
Yearly Cash Flow	$ 224,554	$ 235,782	$ 247,571	$ 259,950	$ 272,947
Cumulative Cash Flow	$ (900,505)	$ (664,723)	$ (417,152)	$ (157,202)	$ 115,745