



# **Milestone Business Park Building #4**

**Germantown, Maryland**

**Kristen M Hlopick**

Construction Management

Dr. Riley

Final Report

April 9, 2008



## THE TEAM

OWNER	KENNEDY ASSOC.
OWNER'S REP	TRAMMELL CROW COMPANY
ARCHITECT	MORGAN GICK MCBEATH & ASSOC.
STRUCTURAL	HAYNES WHALEY & ASSOC.
CIVIL	VIKA INCORPORATED
MEP	B&A CONSULTING ENGINEERS
CONTRACTOR	BUCH CONSTRUCTION

## THE INFO

SIZE	166,292 SF
STORIES	SIX
CONSTRUCTION	06.29.2007 - 09.30.2008
DELIVERY METHOD	DESIGN BID BUILD
COST	~19 MILLION
LEED COST	~477,000
OCCUPANCY	OFFICE SPACE

## THE ARCHITECTURE

- THIRD OF FIVE BUILDINGS ON A 55 ACRE SITE
- LEED CORE AND SHELL; ANTICIPATING SILVER CERTIFICATION
- GLASS ENTRANCE DOORS, ALUMINUM FRAME WINDOW SYSTEM AND DECORATIVE BRICK FACADE TO MATCH BUILDINGS OF PHASE #1.

## THE ELECTRICITY

- MAIN SWITCHBOARD: 4000A, 277/480V, 3 $\phi$ , 4 WIRE
- EMERGENCY POWER: 350KW DIESEL GENERATOR
- TRANSFORMERS: SIX AT 150KVA, OTHERS RANGE FROM 15-45KVA
- LIGHTING: 277V FLUORESCENT (TYPICAL)

## THE STRUCTURE

- FOUNDATION: SPREAD FOOTINGS, 5" SOG WITH 4" GRAVEL BASE
- FLOOR: STEEL BEAMS AND GIRDERS WITH 40'X2 5' (TYP) BAYS, 3 1/4" LIGHTWEIGHT CONCRETE ONTOP A 3" METAL DECK
- ROOF: 1 1/2" METAL DECK TOPPED WITH RIGID INSULATION BOARD

## THE MECHANICS

- PENTHOUSE TO HOUSE ROOFTOP MECHANICAL EQUIPMENT
- SYSTEM DESIGNED FOR 76°F/40% RH FOR SUMMER AND 72°F FOR WINTER
- TWO 1700 GPM COOLING TOWERS
- AIR WATER SYSTEM

KRISTEN MARIE HLOPICK

CONSTRUCTION MANAGEMENT  
[HTTP://WWW.ENGR.PSU.EDU/AE/THESIS/PORTFOLIOS/2008/KMH326/](http://www.engr.psu.edu/ae/thesis/portfolios/2008/kmh326/)



## Final Report

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## Executive Summary

This senior thesis report is an in depth study of Milestone Building #4 of Milestone Business Park in Germantown, Maryland. Research about a critical industry issue affecting this building is included as well as two technical analyses. The technical analyses address opportunities which can be implemented into the project to add value. For each analysis, an argument is used in deciding whether the ideas should be executed.

The critical industry issue affecting Milestone Building #4 is the knowledge of LEED requirements for trade contractors. This issue has been researched through surveys and interviews. It has been found, that when implementing LEED design into a project for the first time, many trades are unfamiliar with the requirements associated with each credit. The research is focused on MR 2 Construction Waste Management, MR 3 Recycled Content and MR 5 Local/Regional Materials. A LEED Guide for Trade Contractors along with a LEED Information Pamphlet has been designed to aid trade contractors with the requirements of LEED design.

The first technical analysis designs an energy efficient, sustainable and environmentally friendly tenant space. The space is designed for requirements given by the client; WeatherBug<sup>®</sup>. The space is designed according to LEED Commercial Interiors. However, since this is only a small space within the entire building, it is hard to identify a certification. Many materials were specified that are energy efficient and sustainable. Even though an accurate estimate wasn't performed, it is common that energy efficient spaces have a higher initial cost. This high cost is offset by a lower life cycle cost, environmentally friendly and a healthier work atmosphere.

The second analysis compares impervious asphalt parking lot to a parking structure and a structural design has been conducted. It has been found that the schedule and cost for the parking garage is greatly increased but other benefits have found. A parking garage frees up space on site to allow for other LEED credits; Protect and Restore Habitat, Maximize Open Space and Non-Roof Heat Island Reduction. Also, since the parking lot has been eliminated, the space can be utilized for other uses.



## Introduction and Project Background

Milestone Business Park is located in Germantown, Maryland, approximately 30 miles NNW of the nation’s capital. The Business Park is a 44 acre site that will be constructed in three phases. Concentrating on Building #4, this is the second phase and third of five buildings in the development. Along with the construction of Building #4, additional surface parking will be added due to the expansion and potential growth of the Business Park.

Milestone Building #4 is a LEED Core and Shell project with a total proposed score of 33 points or Silver Certification. The design team utilizes all five LEED categories; Sustainable Sites (8 points), Water Efficiency (5 points), Energy and Atmosphere (3 points), Material and Resources (3 points) and Indoor Environmental Quality (10 points). The project will also receive four (4) points for Innovation in Design which includes a LEED AP, Exemplary performance, Education/Outreach and Green Housekeeping.

PURSE	PLANET	PEOPLE
<p><b>First Cost Savings</b></p> <ul style="list-style-type: none"> <li>- Reduced infrastructure costs</li> <li>- Reduced material use</li> <li>- Savings in construction waste disposal</li> <li>- Savings from downsizing mechanical equipment</li> </ul> <p><b>Reduced Operating Costs</b></p> <ul style="list-style-type: none"> <li>- Lower energy costs</li> <li>- Lower water costs</li> <li>- Greater durability and fewer repairs</li> <li>- Reduced cleaning and maintenance</li> <li>- Reduced cost of churn</li> <li>- Lower insurance costs</li> <li>- Reduced waste generation within the building</li> </ul> <p><b>Other Economic Benefits</b></p> <ul style="list-style-type: none"> <li>- Increased property value</li> <li>- More rapid lease-out</li> <li>- Easier employee recruiting</li> <li>- Reduced employee turnover</li> <li>- Reduced liability risk</li> <li>- Staying ahead of regulations</li> <li>- Positive public image</li> <li>- New business opportunities</li> </ul>	<p><b>Environmental Benefits</b></p> <ul style="list-style-type: none"> <li>- Reduced global warming impacts</li> <li>- Minimized ozone depletion</li> <li>- Reduced resource extraction impacts</li> <li>- Reduced toxic emissions</li> <li>- Reduced energy and other impacts of transporting materials</li> <li>- Reduced contributions to local and regional air pollution</li> <li>- Reduced local and regional water pollution</li> <li>- Reduced urban heat islands</li> <li>- Protection of biodiversity</li> <li>- Increased environmental awareness</li> </ul>	<p><b>Health and Productivity Benefits</b></p> <ul style="list-style-type: none"> <li>- Improved health</li> <li>- Enhanced comfort</li> <li>- Reduced absenteeism</li> <li>- Improved worker productivity</li> <li>- Improved learning</li> <li>- Faster recovery from illness</li> <li>- Increased retail sales</li> </ul> <p><b>Social Benefits</b></p> <ul style="list-style-type: none"> <li>- Support of sustainable economies</li> <li>- Support of companies with socially responsible policies</li> </ul> <p><b>Community Benefits</b></p> <ul style="list-style-type: none"> <li>- Reduced demand on municipal services</li> <li>- Reduced erosion and stormwater runoff</li> <li>- Reduced automobile use, traffic congestion and sprawl</li> <li>- Creating “community”</li> <li>- Support of local agriculture</li> </ul>





## Project Design Overview

### *Architecture*

Milestone Building #4 is a six story Class A office building; totaling 166,292 square feet. This will be the third of five buildings located at Milestone Business Park. Upon completion, the project team hopes to achieve a LEED Core and Shell rating of Silver. Being the third building on site, Building #4 was design architecturally to match the existing buildings. This similarity includes glass entrance doors, an aluminum frame window system and a decorative brick façade.

### *Demolition*

There is no demolition required for Milestone Building #4.

### *Structural Steel Frame*

The structural steel will be erected in four sections by a mobile crane (Sequencing plan is located in Appendix A.). The steel was designed for dead, live, snow, wind and seismic load according to IBC an ASCE. All 'W' shapes are composed of ASTM A992 steel and all other shapes are conformed to ASTM A36. The structural steel is mainly made up of W21 or W16 shapes carrying a 3 ¼" lightweight concrete slab on top a 3" metal deck.

### *Cast In Place Concrete*

Cast in place concrete is used for the foundation, SOG and elevated slabs. It will be placed directly (foundation and SOG) and by pump (elevated slabs). The footings and grade beams will use 3000 psi concrete and will be formed with plywood. The slab on grade is of 4000 psi while the elevated slabs are of 3500 psi. Concrete was designed to IBC, ASTM and ACI.

### *Precast Concrete*

There is no precast concrete designed for Milestone Building #4.

### *Mechanical System*

The rooftop mechanical equipment is housed in the penthouse and another mechanical room is located on the first floor. The mechanical system is an air water system designed for 76°F/40%RH for summer months and 72°F for winter months. There are two 1700 GPM cooling towers located on the roof.

### *Electrical System*

The main switchboard providing power is designed at 4000A, 277Y480V, 3 $\phi$ , 4 wire. For emergency power, there is a 350KW diesel generator located outside of the south wall. There



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are six transformers at 150KVA, while all others range from 15-45KVA. The lighting in the building is typically 277V fluorescent fixtures.

### *Masonry*

Milestone Building #4 will be ornamented with masonry brick veneer to match Buildings #1 and #2 of Phase I. The primary brick pattern is  $\frac{1}{2}$  running bond, broken up with a soldier brick window head. The use of a tower scaffolding system will be incorporated on Building #4 and the brick veneer will be laid by elevation; south, west, north, east.

### *Curtain Wall*

There is no curtain wall designed into Milestone Building #4.

### *Transportation*

The building consists of four elevators, two on each side of the lobby. One of these elevators serves as a freight elevator, while the other three are strictly used as passenger elevators. All of the elevators have a capacity of 3500 pounds and travel at a speed of 350 feet per minute. The pits are approximately 9' deep with a sump pump in each pit. The penthouse located on top of the building houses the elevator mechanical room. Each elevator is decorated with brick, glass and ornamental railings.

### *Support of Excavation*

There is no excavation support needed for Milestone Building #4.

## **Project Team Overview**

The following are the core member of Milestone Building #4:

Owner	Kennedy Associates
Developer	Trammell Crow Company
Leasing Agent	CB Richard Ellis
Architect	Morgan Gick McBeath and Associates
Structural Engineer	Haynes Whaley and Associates
Civil Engineer	VIKA Incorporated
MEP Engineer	B&A Consulting Engineers
Contractor	Buch Construction



## Client Information

Kennedy Associates has started Milestone Business Park as a speculative office development with a financial return of 10-12%. The LEED design was an initiative of Kennedy Associates and building #4 is the first in the Business Park. Located outside of the nation's capital, it is felt many companies are expanding their service radius. This business park hopes to accommodate the expanding companies that would like another office in a region outside of Washington, DC.

Trammell Crow Company has placed high expectations on Buch Construction through cost, quality, schedule and safety. The cost of the job is what they expected to pay and will hold Buch Construction to it. Safety and quality is of utmost importance on any job. Milestone Building #4 can be classified as Value Engineering, Class A. Trammell Crow and Buch Construction have agreed to a schedule of 12-14 months. As of now, building #4 will be complete late by October 2008. Milestone Building #4 is a core and shell building and currently has no tenants. Once a tenant has been found, the substantial completion date may be altered to satisfy the needs of the tenant. Kennedy Associates and Trammell Crow hope to have building #4 fully leased within 12 months of completion. As of now, there is a brochure used to market Milestone Building #4. A more in-depth marketing strategy is in the works. Upon completion, Trammell Crow will be satisfied with the job completed on time and within budget.

## Project Delivery Method

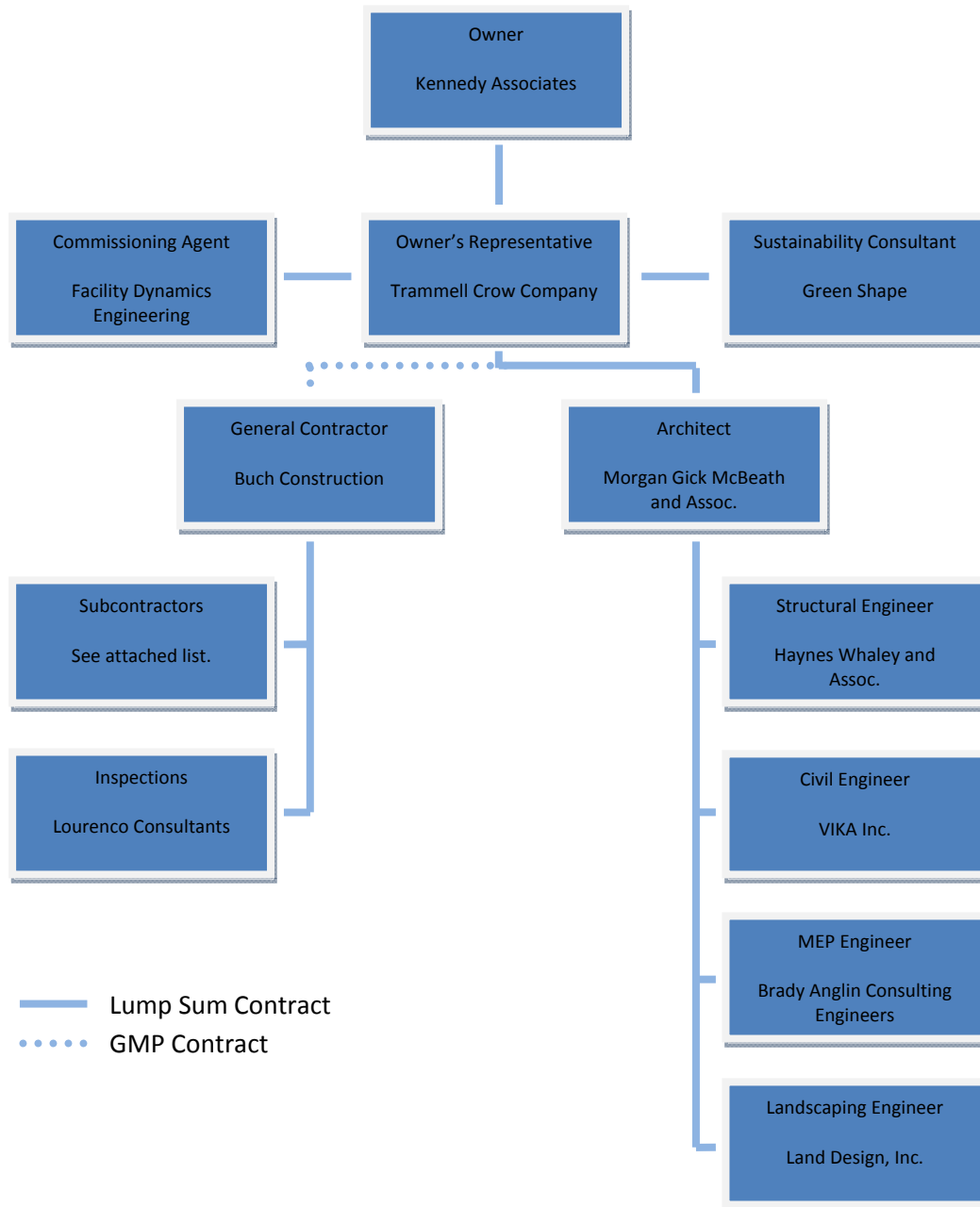
Trammell Crow Company has made Milestone Building #4 a competitive bid, inviting five General Contractors to bid. Buch Construction was one of two finalists. Buch Construction was ultimately chosen for their competitive price, professional business relationships and past experience with the company. Trammell Crow Company and Buch Construction have a guaranteed maximum cost contract with a 4% fee.

While Milestone Building #4 was in bidding phase, it was a non-LEED rated building. However, it was always the intention of Trammell Crow Company and Kennedy Associates to make the building LEED Certified. This played little role in selecting the general contractor. Once the job was awarded, Buch Construction would then wait for the LEED design to finalize and send the changes to their subcontractors. The LEED design was noted as revisions in the drawings and was priced as a change order. The contract amount does not include the LEED revisions.



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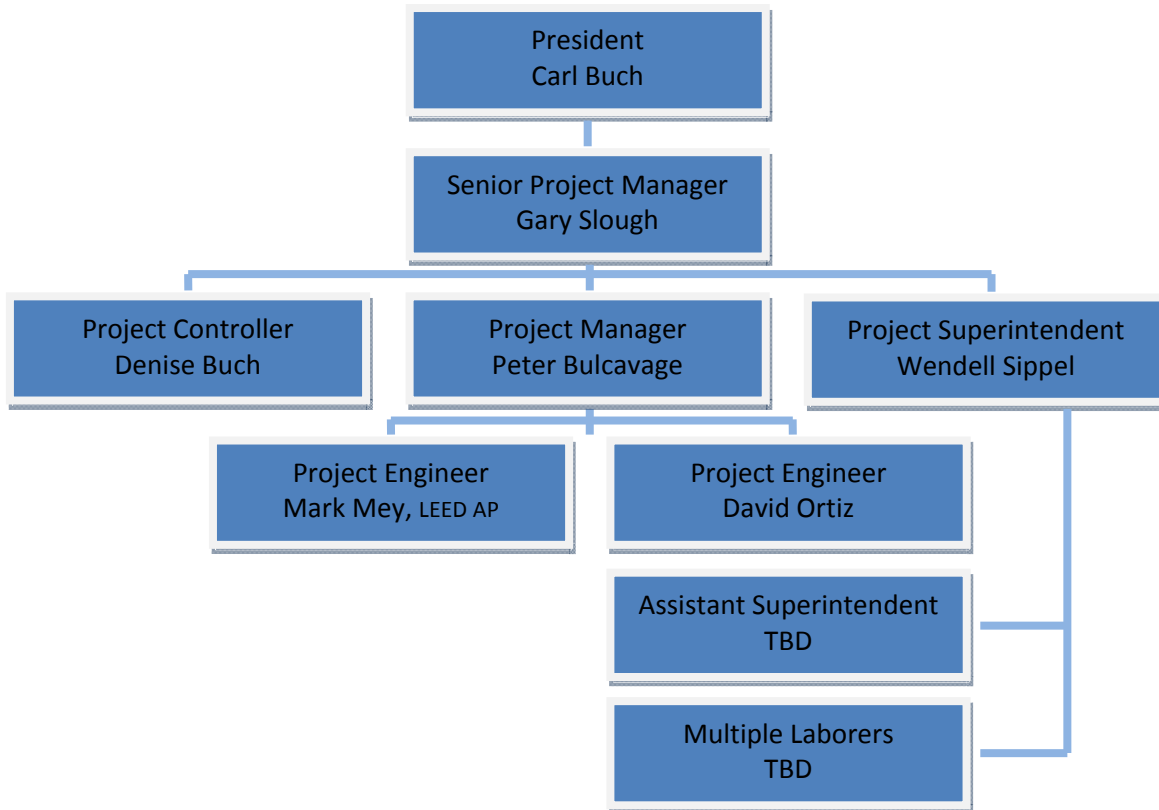
Buch Construction invited three subcontractors of each trade to bid on Milestone Building #4. Since Buch Construction highly values healthy business relationships, selecting which subcontractors to bid the job was based on previous experience with the company. Hence, selecting the ultimate subcontractor was primarily based on price. The contract provides a list of insurance and bonds that Buch Construction should have on all subcontractors.





*Staffing Plan*

Buch Construction follows a typical staffing plan for each job the company is awarded. However, this is one of the larger projects and the first to obtain LEED certification. Due to the unfamiliarity of LEED construction, Buch Construction compensated for this by allocating additional staff. There are two project engineers that will share the duties of RFIs, submittals, and communication with other parties. Mark Mey (Project Engineer) received LEED accreditation, and will serve as the LEED representative for Buch Construction and will communicate directly with the LEED Consultant; Green Shape. Gary Slough (Senior Project Manager) oversees three parties; Peter Bulcavage (Project Manager), Wendell Sippel (Project Superintendent) and Denise Buch (Project Controller). Even though Slough makes most of the final decisions, there is open communication throughout the staff at Buch Construction and are all equally included in all decision making. Once Milestone Building #4 is heavily underway, Sippel (Project Superintendent) will be granted an Assistant Superintendent to divide the responsibilities. Also, under the supervision of Sippel, additional available laborers will arrive onsite as needed.



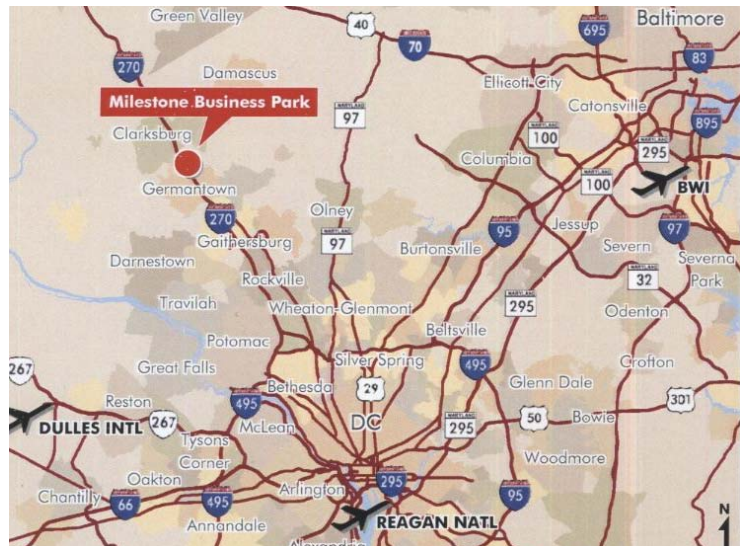


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## Existing Conditions

### *Vicinity Maps*

Milestone Building #4 is located approximately 30 miles NNW of our Nation's capital in Germantown, Maryland. With major thoroughfares to Washington, DC and Baltimore, the Business Park is strategically located off of I-270 to allow for easy commute to both cities.



The picture to the left shows Milestone Business Park. Building #4 will be constructed in the current phase along with asphalt parking to west of Building #4 and expanding south of the existing parking.

### *Local Conditions*

Milestone Building #4 is located on a 44 acre site in a developed suburb northwest of Washington, DC. Since the Business Park is not fully developed yet, a congested site is not an issue. With future development in the

design phase, future buildings and parking lots provide adequate space for storage, lay down areas, parking, trailers, etc.

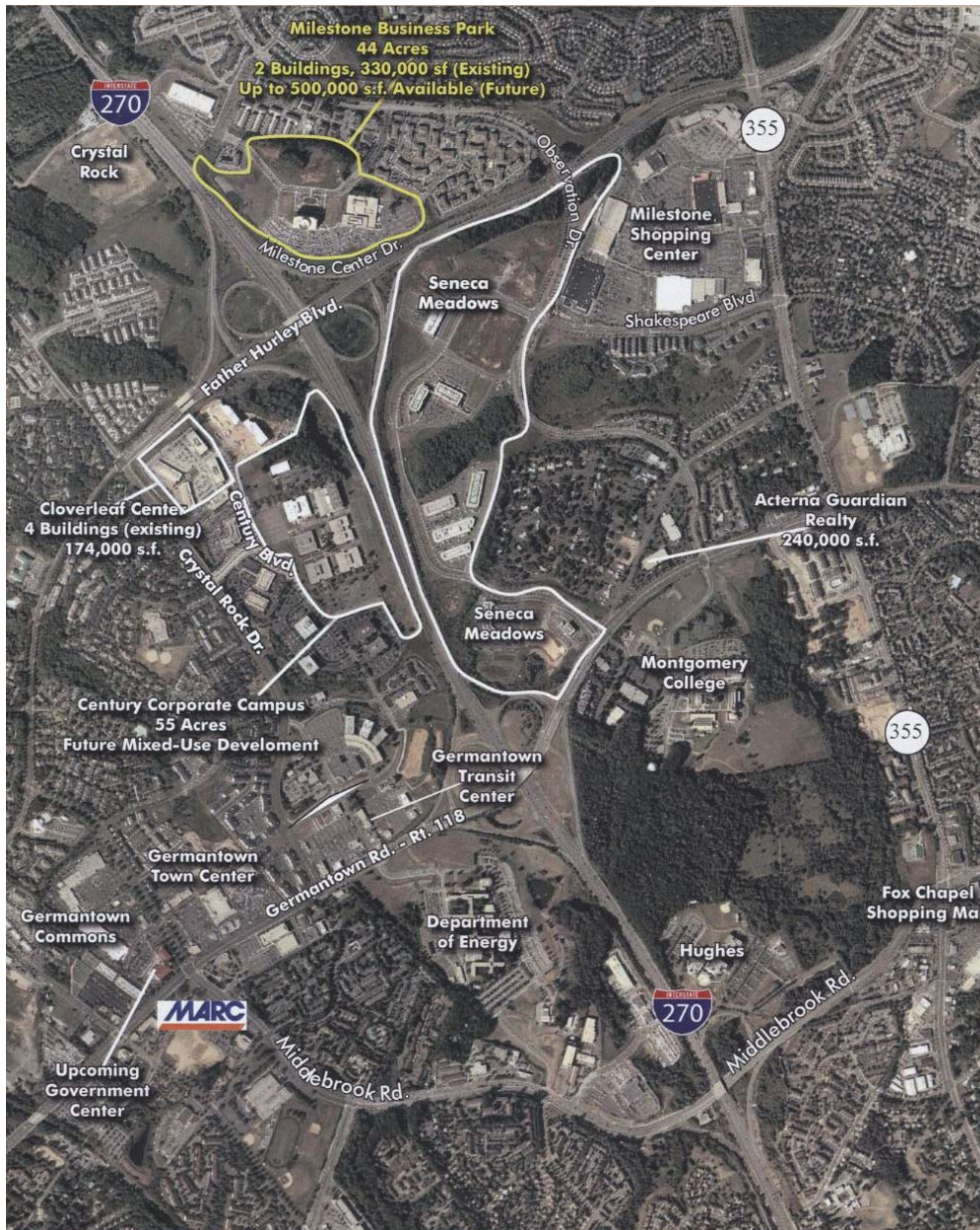
One concern the project team has with the site are the existing tenants and buildings. Building #4 will be built directly next to Building #2. Safety to the existing building and its tenants are of utmost concern. Noise is also a concern to the tenants of Building #2. Construction will begin long before the typical work day and limits the use of construction equipment, which causes



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louder noises, during peak tenant work hours. Deliveries will be limited to non-peak traffic hours (morning, lunch and evening) and will be rerouted through the back entrance.

There are three primary types of soils located on site; topsoil, silty sands/sandy silts and rock. The topsoil averages 5"-6" deep; which allows most of the soils to fall into the medium dense (silty sands/sandy silts) category. Rock begins mainly between 18'-20', however, hitting rock is still a concern at spots due to its depth from surface.





### Existing Site Plan

A detailed site plan of existing conditions can be found in Appendix B.

### Cost Summary

Milestone Building #4 was bid in early May 2007 with a lump sum of ~\$19 million (\$144/sf). Once the general contractor was selected, LEED revisions were completed causing a change order of ~\$478,000. The construction cost breakdown and total building costs are located in the tables below.

#### Total Building Cost

Category	Cost	Cost/SF
Construction Cost	\$17,586,084	\$106/sf
General Conditions	\$700,000	\$4/sf
Bond, Insurance, Misc.	\$720,716	\$4/sf
LEED Change Order	\$477,841	\$3/sf
<b>Total</b>	<b>\$19,484,641</b>	<b>\$117/sf</b>

### Construction Cost

#### Actual Construction Cost

CSI Division	Cost	Cost/SF
Site Construction	\$2,228,986	\$14/sf
Concrete	\$1,380,000	\$8/sf
Masonry	\$1,359,116	\$8/sf
Metals	\$3,223,000	\$19/sf
Woods and Plastics	\$316,000	\$2/sf
Thermal and Moisture Protection	\$1,181,779	\$7/sf
Door, Frames and Hardware	\$1,517,200	\$9/sf
Finishes	\$1,548,577	\$9/sf
Specialties	\$104,687	\$1/sf
Furnishings	\$61,190	\$1/sf
Conveying Systems	\$975,000	\$6/sf
HVAC/Plumbing	\$2,200,790	\$13/sf
Fire Protection	\$288,759	\$2/sf
Electrical	\$1,201,000	\$7/sf
<b>Total</b>	<b>\$17,586,084</b>	<b>\$106/sf</b>





*LEED Change Order*

**LEED Change Order**

<b>Item</b>	<b>Cost</b>	<b>Cost/SF</b>
LEED Coordinator	\$43,866	\$0.26
Waste Management	\$182,249	\$1.10
Materials Protection	\$8,500	\$0.05
Materials Hoist	\$43,525	\$0.26
Concrete	\$4,400	\$0.03
Millwork	\$13,998	\$0.08
Blocking/Rough Carpentry	\$43,000	\$0.26
Moisture Protection	\$3,530	\$0.02
Doors and Hardware	\$225	\$0.00
Glazing	\$1,000	\$0.01
Gypsum Board	\$68,000	\$0.41
Tile and Stone	\$17,372	\$0.10
Carpet	\$212	\$0.00
Paint	\$1,200	\$0.01
Toilet Accessories	\$1,095	\$0.01
Mechanical	\$39,860	\$0.24
Electrical	\$23,169	\$0.14
<b>Subtotal</b>		
	\$434,401	\$2.61
Fee (10% OH&P)	\$43,440	\$0.26
<b>Total</b>		
	\$477,841	\$2.87



### General Conditions

General Conditions	
Supervision - Administrative	\$349,181
Office Management and Clerks	\$5,180
Engineering	\$137,942
Clean Up	\$59,379
Safety Construction	\$19,000
Temporary Facilities and Utilities	\$5,600
Temporary Construction Utilities	\$28,600
Field Office Operation	\$27,700
Security and Fire Protection	\$13,950
Medical	\$500
Hauling, Transportation	\$27,125
Equipment Repairs	\$14,100
Small Tools and Expendables	\$2,500
Taxes, Permits and Licenses	\$9,243
<b>Total</b>	<b>\$752,052</b>

### Project Schedule

Milestone Building #4 went to bid in early May 2007 and received Noticed to Proceed at the end of June 2007. However, there were many issues regarding permits and was unable to break ground until Mid-September. The construction project had an original schedule of 12-14 months; with substantial completion in September 2008. Due to permit problems, Buch Construction hopes to complete Milestone Building #4 late October 2008. A detailed project schedule can be found in Appendix C.

#### Foundation

The site of Building #4 was previously landscaped during phase one due to its close proximity of Building #2. Therefore only removal of trees and very little excavation is needed. The foundation consists of spread footings and concrete piers topped with a 5" slab on grade.

#### Structural

Steel will be erected by a mobile crane in four sections; south (floors 1-3), north (floors 1-3), south (floors 4-6, roof), north (floors 4-6, roof). Please see attached drawing in Appendix A for sequencing. Once steel has erected, decking and concrete will follow. Concrete will be placed



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with a pump and each floor will have two pours. Upon completion of all elevated slabs and roof, roof will be sealed and closed in.

### Finishes

Due to Milestone Building #4 being a Core and Shell building, the finishes are limited to elevator lobbies and bathrooms. Finishes will be done in a typical ceiling to floor fashion; starting after passing ceiling close-in inspection. Finishes will start on the first floor and move up to the sixth floor.

### Site Utilization Plan

For a detailed Site Utilization Plan – Steel Erection Phase, see Appendix D.

The contractor trailers are located at the front entrance to the site. This location was chosen for two reasons, existing transformer for easy hook-up and ability to coordinate deliveries. Once the trailers have been placed, all deliveries were moved through the back entrance to lessen any disruption to other traffic and building occupants.

There is plenty of room on site for laydown, storage and parking. The one way traffic pattern (as shown on Site Utilization Plan in Appendix D) allows for easy flow of traffic. Milestone Business Drive will remain open, but will have temporary gated closures for large deliveries. If this becomes a problem for traffic control and noise to the building occupants, the delivery trucks have room to turn around west of the site. The crane will pick steel off the truck and place in staging areas. When concrete is being placed, two gates in the fence will open to allow the concrete trucks to drive up to the building and exit without turning around. A temporary large gravel parking lot is located at the northwest corner of the site. Construction personnel can enter the lot through the main road; Milestone Business Drive. Also located in the parking lot are dumpsters, recycling bins and portable toilets, making it an easy location for trash removal.



## Research Topic – LEED Guide for Trade Contractors

### Introduction

#### *Problem/Opportunity Statement*

Green Building is a hot topic in today's industry. However, the client of Milestone Building #4 had to take away LEED points early during construction because of cost, availability of materials, trades, and knowledge within the construction industry. Even though this was not a topic of discussion at the PACE Round Table, I decided to talk to a few industry members at the career fair and Round Table about this issue. After speaking with them, I found that many other companies, when implementing LEED design into a project for the first time, have experienced similar problems.

#### *Goal*

Over the last few months, the goal of the research was to provide industry members and trade contractors with adequate LEED information prior to design and bidding. In particular, the following LEED points have been found to cause the most difficulty: MR 2: Construction Waste Management, MR 4: Recycled Content and MR 5: Local/Regional Materials. These are the only points studied in this research analysis. An information pamphlet and LEED guidelines will be developed. This will not only inform the industry about sustainable buildings but will also aid in excelling in LEED design and construction.

#### *Research Steps*

1. Educate self on LEED criteria and requirements.
2. Learn LEED classification and rating system.
3. Develop information pamphlet for developers, general contractors and trade contractors.
4. Develop list of experienced industry members and a list of industry members that are interested in implementing LEED.
5. Put together a package to send to industry members
  - a. Develop information pamphlet for developers, general contractors and trade contractors.
  - b. Convincing Argument... "Why is this important to you?"
  - c. Write a survey for industry members to find their opinion on sustainability, material conservation ideas, any interest/hesitation and key success indicators.
  - d. Develop a guide to be used by trade contractors
6. Send package to experienced and inexperienced industry members.
7. Process results and develop a more detailed goal if needed.
8. Make any necessary changes based on feedback from industry members.

*For all documents sent to survey consultants see Appendix E.*



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### *Expected Outcomes*

The expected results of this research is to provide trade contractors with information about LEED construction and an easy to use guide that will help them get started on a project. Also, a list of experienced design and construction teams will be available to industry members, so they can prepare a proficient project team early on.

### **LEED Information Pamphlet**

A LEED information pamphlet was created for those who are new to LEEDs. This pamphlet was designed to aid beginners in sustainable building, focusing on LEED applications. This guide was only geared towards the three credits that were part of the research; MR2 Construction Waste Management, MR3 Recycled Content and MR5 Local/Regional Materials. The guide reviews strategies, requirements, calculations, submittal documentations and example templates. The LEED Pamphlet can be found in Appendix E.3.

### **Survey**

The following survey was sent out to industry members to gauge their knowledge of LEED requirements in the construction industry. The survey was sent to building owners, developers, design engineers, architects, contractors, suppliers and manufacturers. The feedback obtained from this survey would also provide a more defined direction for this research.

#### **SECTION 1**

What kind of company do you work for?

- Owner
- Architect
- Construction Manager
- General Contractor
- Trade Contractor
- Supplier
- Manufacturer
- Other: \_\_\_\_\_

Have you participated in the design or construction of a LEED certified building?

- Yes. Please proceed to SECTION 2
- No. Please proceed to SECTION 3

#### **SECTION 2**

How many LEED certified building did you take part in?



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What were the ratings?

- Certified
- Silver
- Gold
- Platinum

If you are a trade partner, supplier or manufacturer, did you have any problems implementing the needed requirements for the anticipated LEED points: MR 2 (Construction Waste Management), MR 4(Recycled Content), MR 5(Local/Regional Materials)?

- Yes
- No

If yes, please provide explanation.

Was there any trouble obtaining verification information needed for submittals?

- Yes
- No

If yes, please provide explanation.

When fulfilling requirements for MR 2 Construction Waste Management, what method was used?

- third party to separate co-mingled trash
- separate recycling bins on site for different materials

Why did you choose this method?

Where there any complications?

Did you have any trouble finding products with the noted recycled content in MR4 Recycled Content?

- Yes
- No

If yes, please provide explanation.

Was there any trouble finding local materials, suppliers and/or manufacturers for MR 5 Local Materials?

- Yes
- No

If yes, please provide explanation.



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**SECTION 3**

Would your company be interested in pursuing a LEED project?

Yes

No

If yes, are you looking to start a LEED project?

If no, please provide explanation.

Do you feel that you have adequate knowledge of the LEED design and construction?

Yes

No

Please provide explanation.

What factors do you feel that have preventing your company from taking part in a LEED project?

**SECTION 4**

Was the LEED implementation process successful?

Yes

No

Please provide explanation.

For trade contractors, was this your first LEED project?

Yes

No

If yes, did you find that when implementing the LEED process for the first time, that you had trouble with any of the requirements?

Do you feel that a LEED guide made for trade contractors would be beneficial when implementing LEED into a construction project?

Yes

No

Do you have any suggestions for what can make this process smoother?

As a trade contractor, do you have your own thoughts about recycling materials that is not mentioned in the LEED guidelines?



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What benefits have you seen in the LEED projects? Are you happy with your decision in taking part of a LEED project?

Please feel free to add any additional comments.

## LEED Guide Examples

Before a LEED guide could be developed, the industry needs to know the importance of sustainable building in today's construction industry. The following introduction was sent in the package along with LEED Guides for Trade Contractors, LEED Pamphlet and a survey:

"...LEED design is a hot topic in today's industry and you can't go a day without hearing about green, sustainability or energy efficient. After graduation, I will be working with construction teams in and around the nation's capital. The city's master plan calls for all new construction to be LEED certified. With this in mind, I developed my research topic. To achieve this goal, trade contractors must be prepared to implement LEED changes into their projects. Once proficient with LEED concepts, contractors will benefit by being called back for future jobs..."

Three LEED guides were developed for trade contractor for credits MR2 Construction Waste Management, MR3 Recycled Content and MR5 Local/Regional Materials. The guides were divided into requirements for submittals, design and construction waste management.

The guides are made in Microsoft Excel and come in both a matrix and list format. The matrix has specification sections across the top and the respective requirements across the left side. An "X" is placed in some boxes where I felt this could be a commonplace. This guide is meant to be project specific. Therefore, more specification sections and requirements can be added or deleted and the X's can be changed. With that said, this matrix can become very large and hard to read.

The list format provides a list of where the X's are located. This is broken down into two lists; by specification section or by requirement (submittal, design and construction waste management). This format is cleaner and easier to understand.





*Submittals*

This document shows some of the requirements needed to complete the documentation process for the submittals.

<b>Construction Submittals</b>		S.1	S.2	S.3	S.4	S.5	S.6
		01 7419	03 2000	03 3000	03 4500	04 0510	04 2000
		Construction Waste Management and Disposal	Concrete Reinforcing	CIP Concrete	Precast Architectural Concrete	Masonry Mortaring and Grouting	Unit Masonry
CS.1	LEED letter template for Credit MR 2.1 and Credit MR 2.2, signed by contractor, tabulating total waste material, quantities diverted and means by which it is diverted and statement that requirements for the credit have been met.	X					
CS.2	Submit certification/letter from material supplier(s) indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content for Credit MR 4		X	X	X	X	X
CS.3	Provide documentation identifying manufacturer and extraction, harvest, and/or recover location of materials provided under this section for Credit MR 5		X	X	X	X	X

The full matrix and list formats of the Submittal Requirements can be found in Appendix E.5.



*Design Requirements*

In the LEED Reference Guides, design requirements are geared toward the design team. However they can be helpful for trade contractors as well, while they are compiling their needed documentation.

Design Requirements		S.1	S.2	S.3	S.4	S.5	S.6	S.7	S.8	S.9	S.10	S.11	S.12
		03 3000	03 4500	04 0510	04 2000	04 2000	04 7313	05 1200	05 3100	05 4000	05 5000	05 5100	05 5200
		CIP Concrete	Precast Architectural Concrete	Masonry Mortaring and Grouting	Unit Masonry - Brick	Unit Masonry - CMU	Calcium Silicate Building Stone	Structural Steel Framing	Steel Decking	Cold-Formed Metal Framing	Metal Fabrications	Metal Stairs	Metal Railings
DR.1	Materials shall be manufactured and of raw materials extracted within 500 miles of project site.	X	X	X	X	X	X	X	X	X	X	X	X
DR.2	Provide products from manufacturers with program for reclaiming construction scrap, waste materials, and packaging.									X		X	
DR.3	Provide materials with recycled content such that sum of post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 10% to 20%.			X									
DR.4	Provide materials with recycled content such that sum of post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 10% to 25%.	X											

The full matrix and list formats of the Design Requirements can be found in Appendix E.6.



**Construction Waste Management**

The Construction Waste Management guide was developed to aid trade contractors onsite when recycling waste. The document shows what can be recycled or reused for each specification section. This helps mostly when there is recycling bins on site instead of using a third party recycler.

<b>Waste Management</b>		S.16	05 7313	Tempered Glass Railings																	
		S.17	06 1053	Misc. Rough Carpentry																	
		S.18	06 16435	Gypsum Sheathing																	
		S.19	06 6400	Architectural Woodwork																	
		S.20	07 1616	Building Insulation																	
		S.21	07 1616	Cementitious Waterproofing																	
		S.22	07 2100	Thermal Insulation																	
		S.23	07 4220	Metal Panels																	
		S.24	07 5400	Thermoplastic Membrane Roofing																	
		S.25	07 8116	Cementitious Fireproofing																	
		S.26	07 8400	Firestopping																	
WS.59	Separate and recycle waste materials in compliance with Waste Management Plan	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
WS.60	a. Place materials defined as hazardous or toxic waste in designated containers.								X										X	X	
WS.61	b. Use trigger operated spray nozzles for water hoses														X				X	X	X
WS.62	c. Fold up metal banded, flatten, and place in designated area.			X															X		
WS.63	d. Collect wood packing shims and pallets and place in designated area	X																	X		
WS.64	e. Separate corrugated cardboard in compliance with Waste Management Plan and place in designated areas for recycling.	X																	X	X	

The full matrix and list formats of the Construction Waste Management Requirements can be found in Appendix E.7.



### Survey

Upon reviewing the LEED Guidelines for Trade Contractor Documents, the industry members were asked to complete the following survey.

Was this guide easy to understand?

Yes

No

Please provide explanation.

Was it user friendly?

Yes

No

Please provide explanation.

Did you find it helpful?

Yes

No

Please provide explanation.

Do you have any suggestion as to how this guide can be improved?

### Survey Results and Findings

For all feedback regarding the opinion and LEED Guide surveys, please see Appendices E.8 and E.9 respectively.

#### *Opinion Survey*

The results of the survey verified that there are still kinks in the LEED design, construction and documentation process. Some of the findings that caught my eye are summarized below.

Was there any trouble obtaining verification information needed for submittals?

The process obtaining the information wasn't hard, but each project seemed to have a different documentation and reporting process. There are also some trades that are slightly behind the LEED learning curve which makes it difficult to obtain documents required for submittals.

When fulfilling requirements for MR 2 Construction Waste Management, what method was used?

The results of this question were split equally; hired a third party to separate co-mingled trash and provided recycling bins on site for different materials. The preferred method seems to be



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allowing a third party to separate trash, even though this method is more expensive. This seems to be for the following reasons; not enough recycling bins were on site, so other recyclables were sent to the landfill and multiple chutes will be needed on a high-rise building, one for each recycling bin.

#### Did you have any trouble finding products with the noted recycled content in MR4 Recycled Content?

The results of this question indicated varying degrees of difficulty locating products. The most common reason identified for this seemed to indicate that some trades were behind the curve and weren't prepared to obtain the proper documents.

#### Were there any troubles finding local materials, suppliers and/or manufacturers for MR 5 Local Materials?

The results of this question implied that there seems to be difficulty finding products that are extracted, harvested and manufactured within the 500 mile radius set by United State Green Building Council as a LEED requirement. Many of these products are custom made and had to be sent to a different plant. Another complication is due to the fact that the products selected by the architect aren't manufactured locally. For example, Venetian rugs and European light fixtures.

#### Do you feel that you have adequate knowledge of LEED design and construction?

The feedback received regarding this question was most astounding. All industry members felt they do not have adequate knowledge of LEED. This is causing them not to pursue LEED projects or to learn as they go. For industry members that have been involved with multiple LEED projects, many find that there is a different method and strategy with each job and have to "reinvent the wheel" each time. A comment that reappears throughout the surveys is that there is no central source for LEED guidelines, it seems to be done on a job-by-job basis and the methods need to be more standardized.

#### Would your company be interested in pursuing a LEED project? What factors do you feel that have preventing your company from taking part in a LEED project?

All but one response indicated they are interested in pursuing a LEED project. However the setbacks lie in the financial aspects and lack of knowledge. These reasons stem from each other. The lack of knowledge about LEED find many companies spending more time designing, bidding, constructing, and documenting the process. In some instances one member of the staff is taken away from the construction team and place as a full time LEED consultant.



Do you feel that a LEED guide made for trade contractors would be beneficial when implementing LEED into a construction project?

All survey consultants agree that a LEED guide for trade contractors would be beneficial, but it needs to be specific. I was impressed to see that there wasn't anything out there that is standardized and could aid in implementing the LEED construction requirements. The guide completed as part of this project works for the rookies but not the veterans.

Do you have any suggestions for what can make this process smoother?

The results to this question were overwhelming. The feedback was great and there seems to be a lot of ideas that can help make the requirements and documentation process smoother. Overall, any guide must be able to be project specific, trade specific and updatable. Two suggestions were to use a computer program or internet site.

#### *LEED Guide Survey*

The results for this survey were unanimous. Out of five responses, all survey consultants agreed that the LEED Guide was easy to understand, user friendly and helpful, thereby meeting the goals identified earlier. However there was a lot of feedback on how the LEED Guidelines for Trade Contractors can be improved.

One opinion said that although it was nice to see specification sections, it was not detailed enough. They wanted to know more about electrical, formaldehyde free substrate or water based adhesives. Another commented that "I think that you are on the right track to try and standardize this package. It is very much needed in the industry. If I may borrow a thing in the tax world that many have adopted to do their taxes is "Turbo Tax". We need a "Turbo LEED" program that is easy to use and applicable to the certification process." This is interpreted as meaning a computer program would be nice where specific questions were asked and general yes or no answers can be given to be directed down the correct path. Lastly, a few industry members mentioned that it might be easier if it was broken down by requirement for each trade and not just by specification sections.

#### **LEED Guide Revisions**

A few revisions were completed to the LEED guide. The goal was to make it user friendly, easy to use and helpful. These goals were accomplished. Feedback from the survey consultants was



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to make the LEED guide more specific to products and broken down by trades. I have added more specific specification sections that are geared toward specific specialty products.

If time permitted, I would like to have broken this down by trade. This is a difficult and time consuming task but would be useful to all trades. Another change is to go further with the LEED guide that I have already completed and turn it into a computer program. This program would act as a flow chart, asking specific yes or no questions until an answer has been reached. An internet site could do the same thing and would be helpful because it is accessible from anywhere.

## Conclusion

After research has been conducted, it is clear that LEED projects are our future and there are still companies that are unfamiliar with all the aspects involved in a LEED project. Trades need to feel comfortable with the design, construction and documentation of LEED to achieve a profitable project. With this, many trades feel it would be beneficial to have a watered down version of the LEED Reference Guide (provided by the United State Green Building Council) and another guide geared towards trade contractors for the LEED requirements.

Upon completing the LEED Guide for Trade Contractors and receiving feedback, I strongly feel that I have achieved my goal. I intended to create this guide and information pamphlet for companies who will implement LEED requirements into construction for the first time. This is a great starting point. There is still a lot of work that can be done to better this guide. This would be to make it more specific to each trade.

Upon completing the research, I found that a sustainability consultant for general contractors would be beneficial. GreenShape is a sustainability consultant located in Washington, DC. GreenShape helps “building developers, architects, engineers and construction teams identify and implement achievable strategies for improved building performance” (GreenShape). GreenShape served as the sustainability consultant on Milestone Building #4 and have been extremely helpful and knowledgeable when it came to design requirements. During design phase, GreenShape reviewed all documents and strategies to make sure they fulfill the design requirement to achieve each anticipated LEED credit. I feel that a similar consultant would be beneficial for the trade contractors. This consultant would serve as the collector of information and assure nothing is left out.



## Architectural Breadth – Interior Tenant Fit Out

### Introduction

#### *Problem/Opportunity Statement*

This technical analysis will design a fit out for the future tenant; WeatherBug®, which has decided to lease the entire building. This is a great opportunity to design a space according to the clients wants and needs. This breadth also has the opportunity to stick with the sustainable aspect by using LEED for Commercial Interiors.

#### *Goal*

Since WeatherBug® is leasing the entire building; the goal of this analysis is to design a space that accommodates high performance green aspects. It is hard to achieve a LEED rating when designing a space only; however ideas from LEED for Commercial Interiors will be utilized. A cost comparison for this design versus non-energy efficient design will also be estimated. The entire design is intended to be incorporated into the construction of the building.

#### *Research Steps*

1. Interview a WeatherBug® representative to gain knowledge of what areas they would like to have in the selected space.
2. Review LEED criteria and decide which ideas I feel are obtainable.
3. Design rough layout and flow of space.
4. Receive input from client.
5. Make necessary changes upon feedback.
6. Review architectural design and high performance elements, to ensure documents coincide. This will provide a more finalized list of anticipated LEED points.
7. Choose materials and if needed, create a set of LEED specifications.
8. Incorporate interior design schedule into overall building schedule.
9. Perform a cost estimate.

#### *Expected Outcomes*

It is expected that high performance green elements will be integrated into the tenant design based on LEED for Commercial Interiors.





## Space Requirements

After interviewing a WeatherBug<sup>®</sup> representative, I had a better insight on what they wanted for their space. The space I was to design is for their Learning Center, which is to be located on the second floor. The following requirements are as follows:

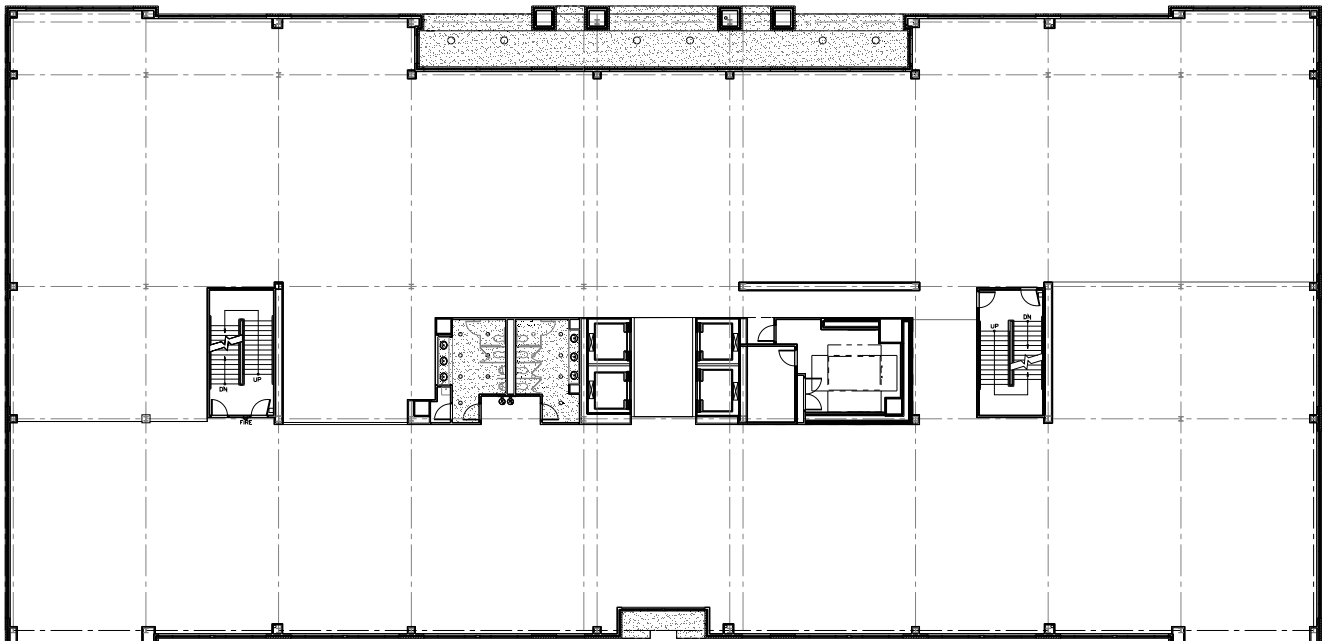
- 6500-7000 SF
- 2 Classrooms
- 2 Conference Rooms (large and small)
- 6 Offices
- 16 Cubicles
- Copy/File/Fax
- Lounge
- Reception Area

Since Milestone Building #4 is a LEED Silver Core and Shell building, I decided to incorporate sustainability ideas into the tenant design. LEED Commercial Interiors ideas were included in the design and material selection. I focused primarily on credit MR3 Recycled Content and MR5 Local/Regional Materials when specifying products and materials.

## Tenant Design

### *Base Building Plan*

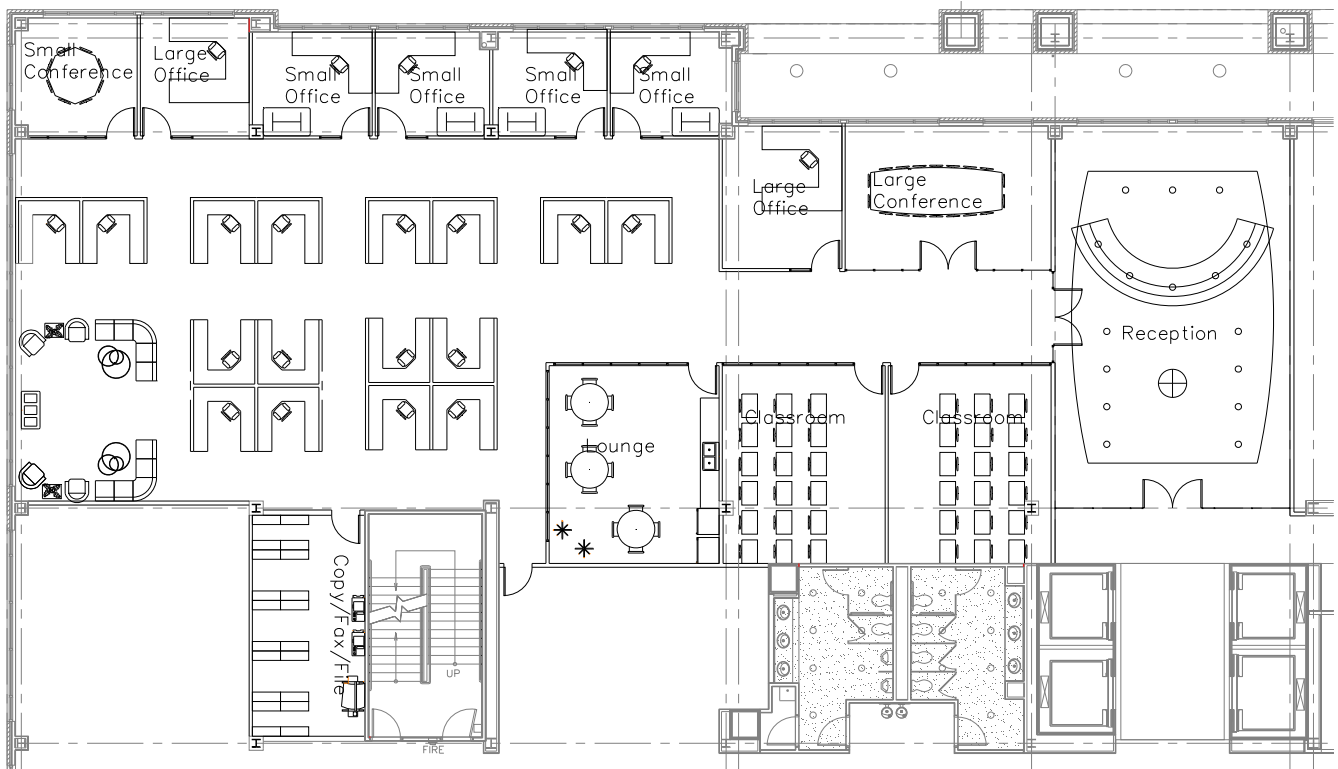
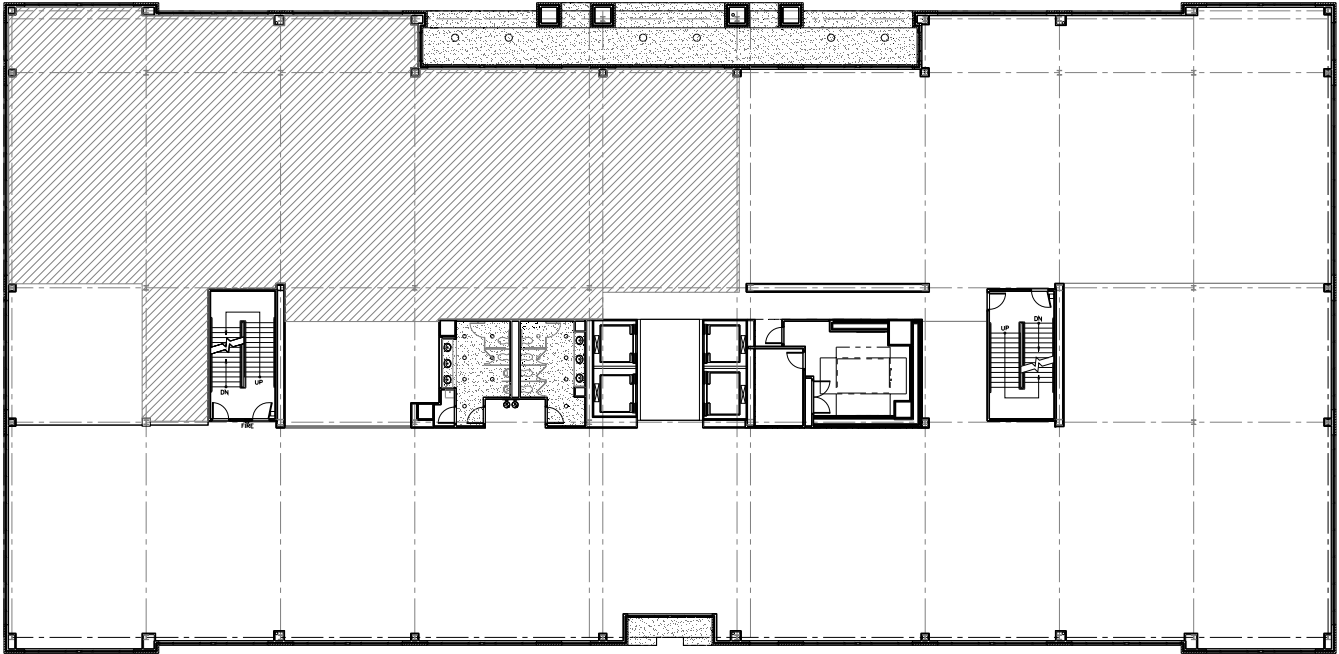
The figure below shows the base building floor plan.





*Tenant Fit Out Design*

The shaded area shows where the Learning Center will be located on the second floor and the tenant fit out design is shown in the following figure.



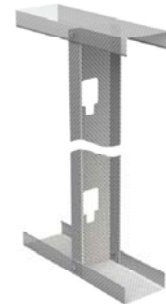


**Material List**

The materials were primarily chosen because of recycled content, harvested, extracted and manufactured locally, energy efficient and have low or no VOC in adhesives and sealants. The following is a list of materials specified for the tenant fit out.

Framing:

Dietrich products contain a high percentage of recycled steel comprised of both post consumer and pre consumer recycled content. Dietrich Metal Framing also is manufactured and contains material sources within 500 miles of the project site. Scrap metal can easily be recycled on the job site.



Millwork:

GreenTech Cabinetry provides a Bamboo Series, which is considered to be a non-toxic rapidly renewable resource. All materials are extracted harvested and manufactured in Gaithersburg, Maryland, located within the 500 mile radius required for LEED MR5.

Doors:

Eggers Industry provides flush doors, frames and a silhouette series that is an FSC (Forest Stewardship Council) chain of custody certified supplier. Eggers’ UV cured finishing system consists of water based stains and clear coats that are VOC free.

EGGERS FLUSH DOORS** LEED Categories and Credit Classifications	PC-5 Agrifiber Core	PC-5 Standard PB Core	PC-5 UFF PB	PC-5 FSC UFF PB	SLC-5 Certified Stave Core	SCLC-5 Structural Composite	MC-5 Mineral Core
Credit MR #4: Recycled Content*	2	2	2	2	0	0	0
Credit MR #6.0: Rapidly Renewable Materials	1	0	0	0	0	0	0
Credit MR #7.0: Certified Wood	0	0	0	1	1	0	0
Credit EQ #4.4: Composite wood, agrifiber and adhesives contain no added urea-formaldehyde***	1	0	1	1	1	1	1
<b>Total points possible with Eggers Flush Doors</b>	<b>4</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>2</b>	<b>1</b>	<b>1</b>

Windows:

As a GreenSeal product, PPG provides interior and exterior window. For the tenant design interior window will be used. PPG uses 20% post industrial recycled glass, low VOC sealants and is considered a local product.



**Gypsum Wall Board:**

National Gypsum offers products that are local to the site and made of 100% recycled content. The figure outlines these findings.

Plant Locations	Post-Consumer MR Credit 4.1 %	Post-Industrial Pre-Consumer MR Credit 4.2 %	Total Recycled Content %	Material Extraction to Plant Miles	Raw Material Extraction Location
<b>GYPSON WALLBOARD PLANTS</b>					
Apollo Beach, FL	5	95	100	1	Tampa Electric Co., Tampa, FL
Baltimore, MD	5	3	8	Over 500	Halifax, Nova Scotia
Burlington, NJ	5	6	11	Over 500	Halifax, Nova Scotia
Fort Dodge, IA	5	4	9	8	Fort Dodge, IA
Long Beach, CA	5	3	8	Over 500	San Marcos, Mexico
Lorain, OH	5	6	11	296	National City, MI
Medicine Lodge, KS	5	3	8	20	Sun City, KS
Mt. Holly, NC	5	95	100	16	Duke Energy Corp., Charlotte, NC
National City, MI	5	3	8	5	Tawas, MI
Phoenix, AZ	5	3	8	102	Winkelman, AZ
Portsmouth, NH	5	3	8	376	Halifax, Nova Scotia
Rensselaer, NY	5	3	8	Over 500	Halifax, Nova Scotia
Richmond, CA	5	6	11	Over 500	Santa Rosalia, Mexico
Rotan, TX	5	3	8	13	Rotan, TX
Savannah, GA	5	3	11	Over 500	Halifax, Nova Scotia
Shippingport, PA	5	95	100	1	First Energy Corp., Shippingport, PA
Shoals, IN	5	11	16	0	Shoals, IN
Tampa, FL	5	3	8	Over 500	Halifax, Nova Scotia
Waukegan, IL	9	13	22	412	Tawas, MI

**Stone and Ceramic Tile:**

EcoTop is composed of FSC certified bamboo fiber (a rapidly renewable resource) and recycled wood fiber (salvaged from demolition sites).



These fibers are bound together with a VOC and petroleum free resin. EnvrioGLAS is comprised of 100% recycled glass which totals 80% of the weight. EnviroGLAS is a local material, with



little or no VOC and can contribute to MR2 Construction Waste Management.

**Acoustical Ceiling Tile:**

Armstrong’s acoustical ceiling tile contributes to EA1 by reducing connected lighter power density. Armstrong also uses 23%-87% recycled content in acoustical ceiling tile and both the tile and suspension systems are manufactured locally.



	CHPS Section 01350	Green Label	Green Label Plus
Chain of Custody / Sample Validation		✓	✓
Test for “Chemicals of Concern”	✓	limited	✓
Annual Testing		✓	✓
Annual Testing for “Chemicals of Concern”			✓
Quarterly Testing for TVOC		✓	✓
Tested Against the Most Stringent Criteria			✓
Certified Laboratory Required		✓	✓
Reproducible Protocols		✓	✓
Annual Audit of Laboratory		✓	✓
Oversight by Scientific Review Board			✓
<b>Bottom line:</b>		✓	✓
<b>Assurance specification = delivered</b>			

**Flooring:**

Lee’s flooring offers modular carpets that are CRI Green Label Plus certified. This improves the indoor air quality by limiting the amount of VOC used. Also these products use 16% pre consumer recycled content and 10% post consumer recycled content.



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### Wallcoverings:

Carnegie Fabrics' Surface IQ wallcoverings are GreenSpec certified, a local material and VOC and PVC free. Carnegie uses 100% recycled polyester to avoid the need to manufacture from virgin materials, saving energy and reducing waste.

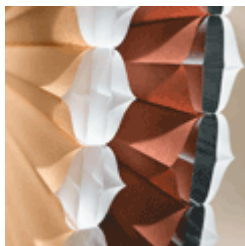


### Paints:

Benjamin Moore offers Eco Spec; a paint that caters to indoor air quality. This product does not have the odor of conventional paints and contains no VOCs.

### Furniture:

National provides a series of products that increase the use of sustainable materials by reducing solid waste by 87%. The furniture line is GREENGUARD certified that aids in improving the indoor air quality. National furniture is also considered a local product.



### Blinds:

Architella Duette Honeycomb Shades by Hunter Douglas are highly energy efficient due to their unique construction; heat in the summer and cold in the winter are captured in honeycombs. These shades are also manufactured locally.

### Lighting:

Seagull Lighting provides many Energy Star products in recessed, pendants, sconces and track lighting. Energy Star products use ¼ of the energy as traditional lighting; this in turn saves money on energy bills and bulb replacements. A typical energy bulb lasts approximately 10,000 hours.





## Conclusion

To conclude, design is a large aspect of an energy efficient and environmental friendly space. The tenant space for WeatherBug® was designed keeping sustainable ideas in mind, while choosing sustainable materials. Even though an estimate wasn't performed on the interior space of Milestone Building #4, it has been found that applying LEED credits and sustainable ideas into the design and construction of any project has an upfront cost that is about 10% more expensive. The lifecycle costs, however, show a substantial savings. Going beyond the price, sustainable buildings are energy efficient, environmentally friendly and provide a healthier work environment.



## Structural Breadth – Impervious Surface Parking vs. Parking Garage

### Introduction

#### *Problem/Opportunity Statement*

A comparative analysis will be done between the existing and proposed impervious surface parking and a parking structure. The main focus of this analysis will be completed from a sustainable point of view. It will include the design and implementation of a parking garage and eliminating the parking lot. At least three sustainable site points can be gained from this proposal. Also, from a structural standpoint, the most efficient and effective system will be investigated and implemented. A cost and schedule analysis will be studied.

#### *Goal*

The intention of this analysis is to incorporate a more sustainable site into Milestone Business Park. By taking away the impervious parking lots, three sustainable site points can be obtained. With the open space on site, a few options can be considered. Instead of driving through the development a road with direct access to Father Hurley Road is feasible. By code, there is a predetermined ratio of pervious surfaces. By eliminating the impervious surfaces, this also allows more space to expand the building, if desired.

#### *Research Steps*

1. Quantify amount of parking spaces needed.
2. Determine allowable site usage.
3. Design parking garage, architecturally.
4. Design parking garage, structurally.
5. Locate a site for the structure.
6. Review cost and schedule impacts. Include the cost to tear up existing parking and implementation of new structure.
7. Brainstorm ideas for new open site.
8. Review cost, schedule and revenue for site ideas.

#### *Expected Outcomes*

An increase in cost and schedule for this analysis is anticipated. However, an implementation of a parking structure will allow for a more sustainable site and community. One concern I have is justifying this proposal as beneficial, even though it will cost more and increase the schedule.



## Comparison

### *Asphalt Parking Lot*

An asphalt parking lot is cheap, easy and fast. However there are some disadvantages to having a site full of asphalt parking. The most critical disadvantage is stormwater runoff. An asphalt parking lot is considered an impervious surface; therefore it will not allow the rain water to seep into the earth. Instead, the water runs off into our stormwater management system picking up oil, antifreeze and other harmful products.

### *Parking Garage*

A parking garage builds up instead of out, allowing for more free space on the site. This decreases the amount of harmful products into our stormwater management system. With more space onsite, the more one is able to do with the site. For example, additional buildings, increase current building size and the nice view of an arboretum. However, some codes and zoning variances limit the building area per site. This is the instance at Milestone Business Park. As I implement the parking garage and utilize more building square footage onsite, this square footage can be used as a green roof on Milestone Building #4.

### *LEED Benefits*

The owner of Milestone Business Park and Building #4 gave up three LEED credits by implementing the asphalt parking lot; SS 5.1 Site Development (Protect or Restore Habitat), SS5.2 Site Development (Maximize Open Space) and SS7.1 Heat Island Reduction (Non-Roof).

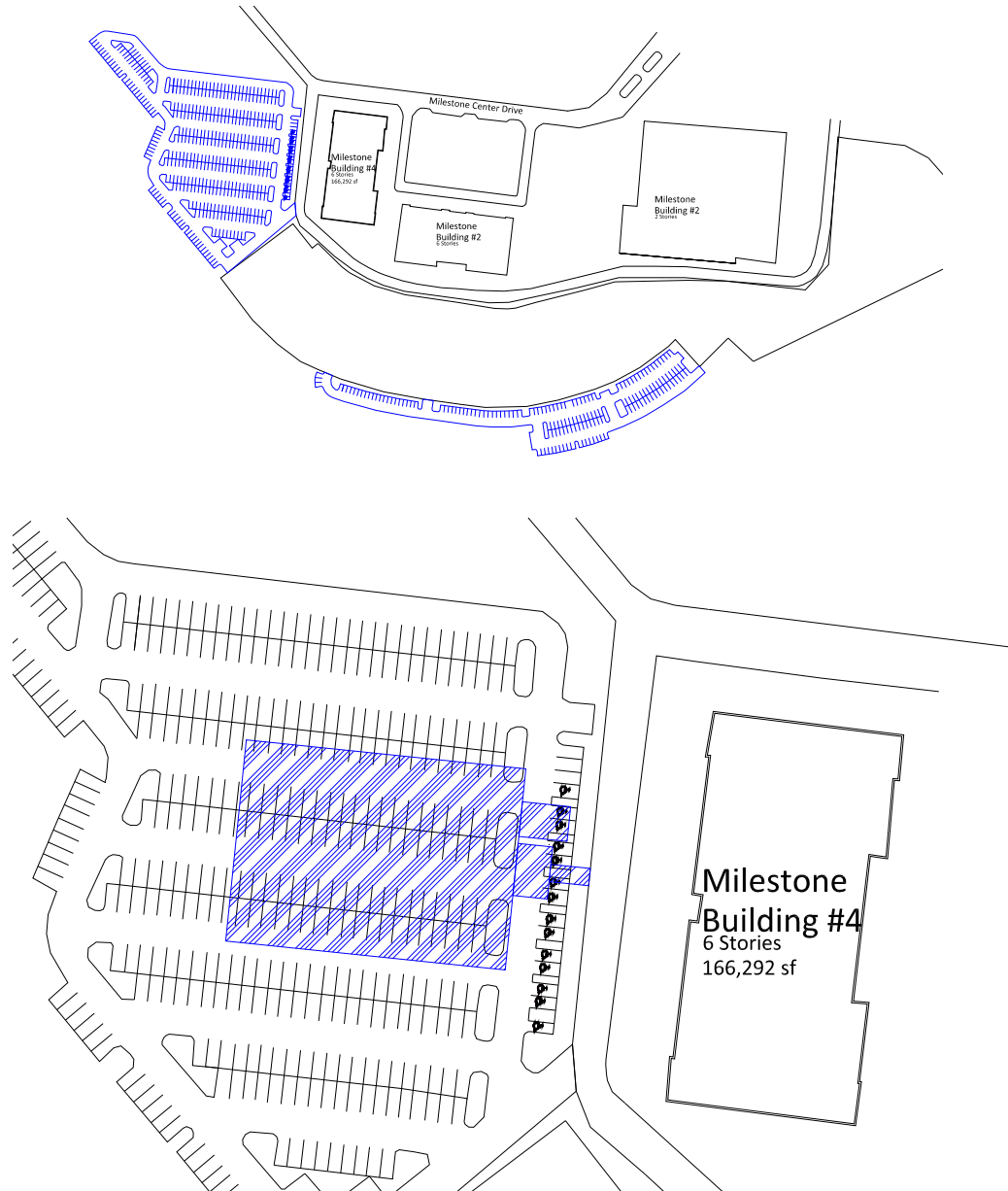
## Site Plan

The figures below show the location of the asphalt parking lot addition to this phase and parking garage on site. The placement of the structure was strategically located across the entrance to Building #4 and an easy road connection with the existing road, Milestone Center Drive.





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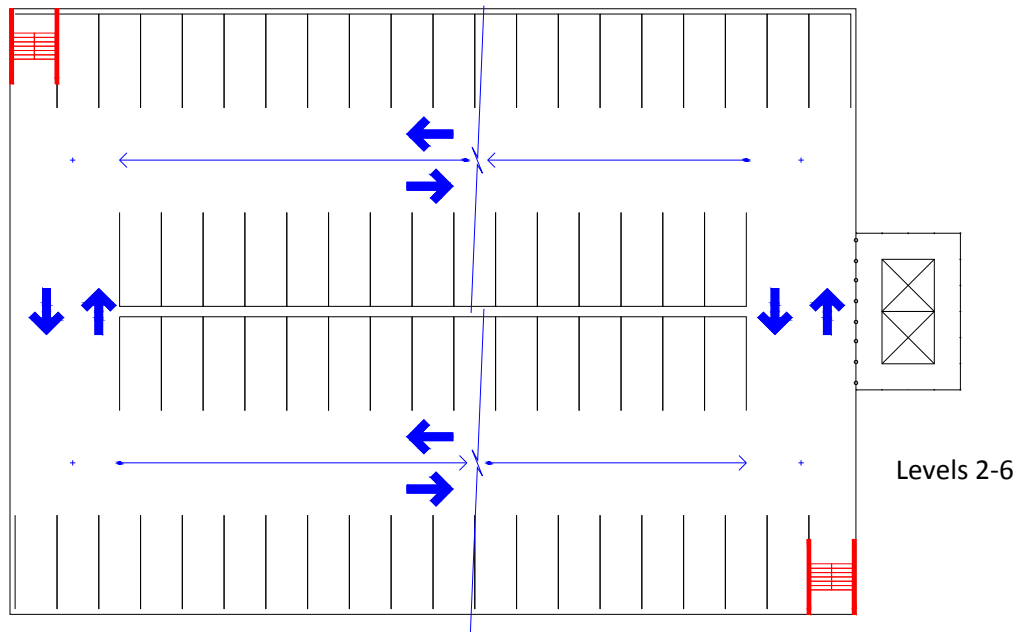
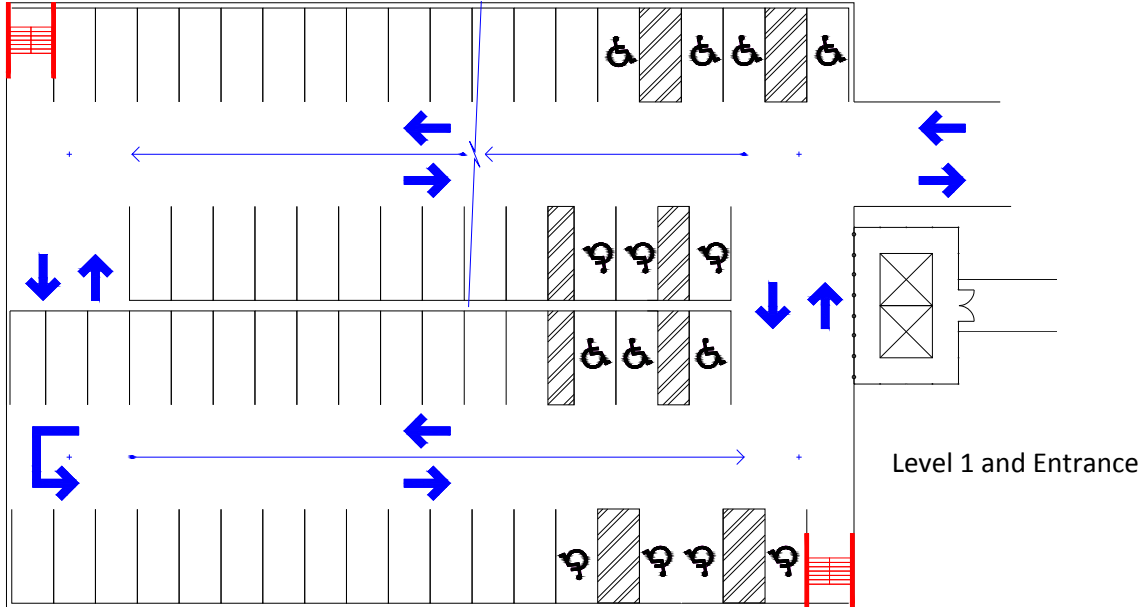


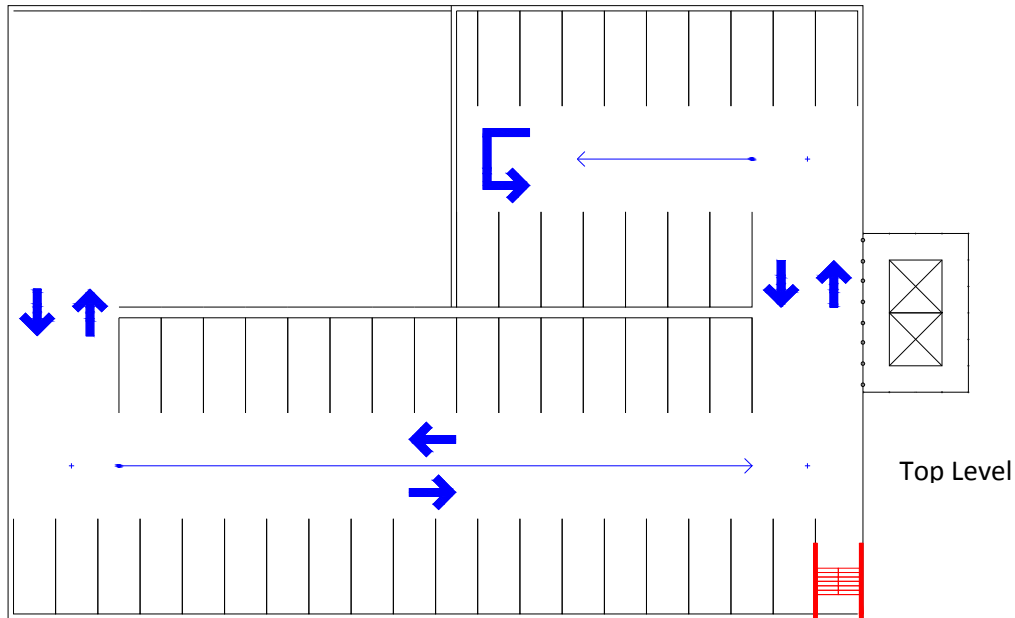
### Architectural Design

The purpose of this breadth is to look at the structural aspects. But before the structural design can begin, an architectural design needed to be complete. The parking garage was designed architecturally just enough to show that it is feasible. There are 714 parking spaces, including 14 handicap spaces in the parking lot located to the west of Building #4. The designed parking garage includes 429 parking spaces, including 14 handicap spaces. The main design idea was taken from the HUB Parking Deck located in University Park.



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HUB Parking Deck  
Sample Elevation

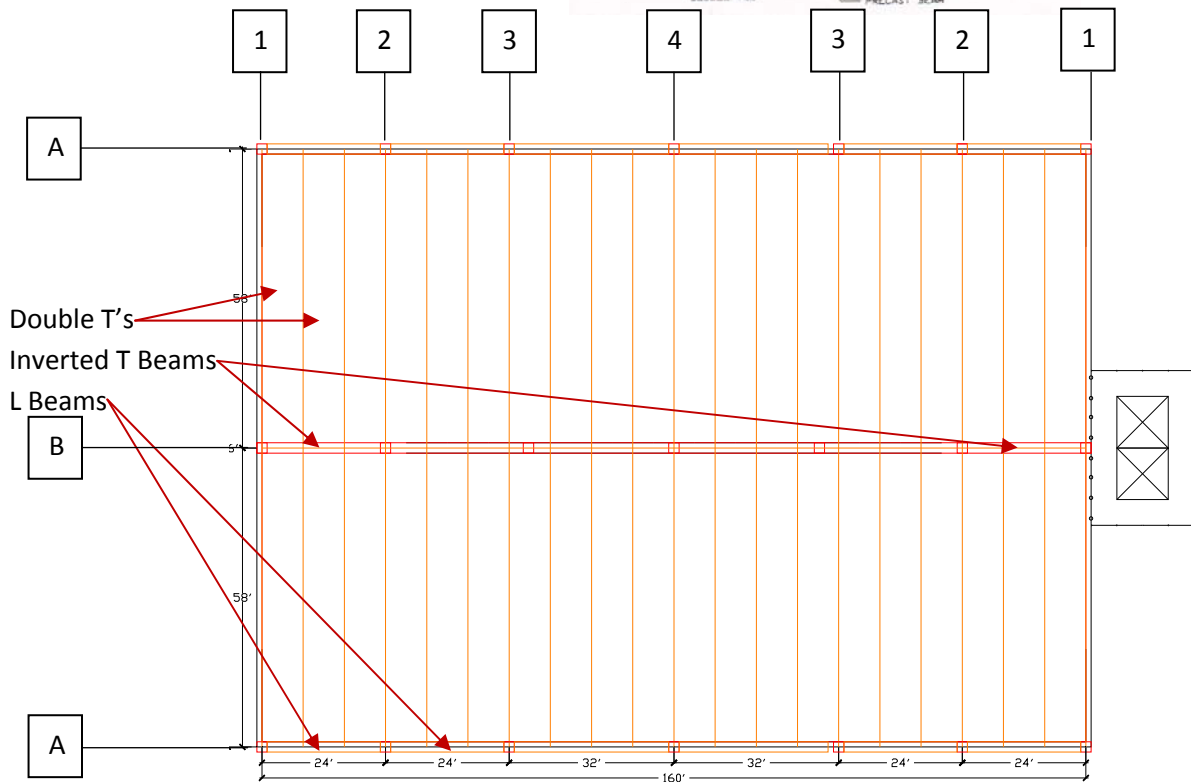
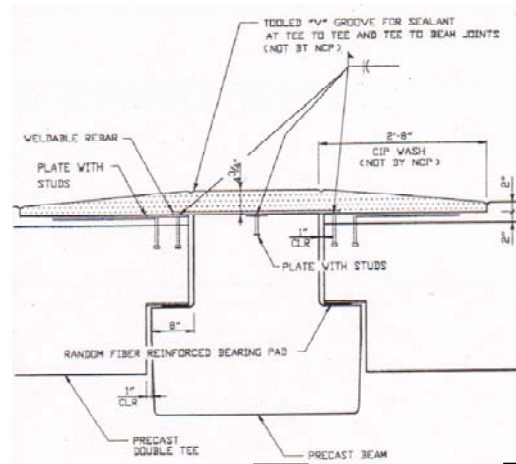
### Structural Design

The overall building dimensions are 116'X160' with a deck height of 9'. Precast concrete columns, double T's, L beams and inverted T beams were the main focus. The incline is set at ~4.6%. Therefore the lateral load that it places on the columns is negligible. Also, the parking garage is designed to take all wind loads by the shear walls (located at stairwells), leaving only



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axial loads on the columns. The American Society of Civil Engineers Standard (ASCE7-05) states that the live load and snow load for a parking garage in Germantown, Maryland are 40 psf and 25 psf respectively. Connections were not taken into consideration, however the following pictures show typical connection details.



*PCI Design Handbook*

PCI Design Handbook was used to size the following members; double T's, L beams and inverted T beams. The design charts can be found in Appendix H.



### PCAColumn

PCAColumn was utilized for the design of the all the columns, backed up with hand calculations. Three column sizes were used to keep the building as uniform and as easy to construct as possible. PCAColumn calculations are located in Appendix I.

### Hand Calculations

The following formulas and calculations were conducted to find loads on the columns, beams and foundation.

$$\text{Live: } P = 618plf(58') + 8'(40psf)(58') = 54,404 \text{ lbs}$$

$$P = 618plf(29') + 8'(40psf)(29') = 28,072 \text{ lbs}$$

$$\text{Live + Snow: } P = 618plf(58') + 8'(65psf)(58') = 66,004 \text{ lbs}$$

$$P = 618plf(29') + 8'(65psf)(29') = 33,002 \text{ lbs}$$

$$\text{L Beam: } w_l = \frac{28.1K(3)}{24'} = 3,512.5plf$$

$$w_{l+s} = \frac{33.1K(3)}{24'} = 4,137.5plf$$

$$w_l = \frac{28.1K(4)}{32'} = 3,512.5plf$$

$$w_{l+s} = \frac{33.1K(4)}{2432'} = 4,137.5plf$$

$$\text{Inverted T: } w_l = \frac{54.4K(3)}{24'} = 6,800plf$$

$$w_{l+s} = \frac{66.1K(3)}{24'} = 8,262.5plf$$

### Columns:

$$\text{A1 } P_l = 28.1K(1.5) = 42.15K$$

$$P_{l+s} = 33.1K(1.5) = 49.65K$$

$$\text{A2 } P_l = 28.1K(3) = 84.3K$$

$$P_{l+s} = 33.1K(3) = 99.3K$$

$$\text{A3 } P_l = 28.1K(3.5) = 98.35K$$

$$P_{l+s} = 33.1K(3.5) = 115.85K$$

$$\text{A4 } P_l = 28.1K(4) = 112.4K$$

$$P_{l+s} = 33.1K(4) = 132.4K$$

$$\text{B1 } P_l = 54.4K(1.5) = 81.6K$$

$$P_{l+s} = 66.1K(1.5) = 99.15K$$

$$\text{B2 } P_l = 54.4K(3) = 163.2K$$

$$P_{l+s} = 66.1K(3) = 198.3K$$

$$\text{B3 } P_l = 54.4K(3.5) = 190.4K$$

$$P_{l+s} = 66.1K(3.5) = 231.35K$$

$$\text{B4 } P_l = 54.4K(4) = 217.6K$$

$$P_{l+s} = 66.1K(4) = 264.4K$$



**Member Sizes**

**Double T's**

D+L:	8DT24 + 2" topping slab	108-S
D+L+S:	8DT24 + 2" topping slab	128-D1

**L Beams**

24'	D+L:	20LB24	108-S
	D+L+S:	20LB28	128-S
32'	D+L:	20LB32	148-S
	D+L+S:	20LB36	168-S

**Inverted T's**

D+L:	28IT32	158-S
D+L+S:	28IT36	168-S

**Columns**

20x20	Bars: (12) #10	B3 (Level 1), B4 (Levels 1-2)
18x18	Bars: (8) #10	B2 (Levels 1-3), B3 (Level 2-4), B4 (Levels 3-5)
14x14	Bars: (4) #8	A1-A4, B1, B2 (Levels 4-6), B3 (Levels 5-7), B4 (Level 6-7)

**Cost**

The total square foot cost was calculated using RS Means.

**RS Means - Parking Garage**

SF Area	115,000	145,000	125,334	Building Cost
LF Perimeter	638	723	556	
Cost/SF	\$44.65	\$43.50	\$44.25	\$5,546,030
Adjustments				
Perimeter	\$1.05	\$0.85	\$1.38	\$172,961
Story Height	\$0.45	\$0.40	\$0.50	\$62,667
Additives				
Elevator			\$2.84	\$356,440
<b>Total Cost/SF</b>			<b>\$48.97</b>	<b>\$6,138,097</b>

**Perimeter Adjustment (LF) Cost/SF**

	<b>Design Case</b>
--	--------------------



<b>Adjustment Case</b>		638'	723'	556'
	100'	\$1.05	\$0.85	\$1.24
	111.28'	\$1.17	\$0.95	<b>\$1.38</b>

**Story Height Adjustment (Ft) Cost/SF**

		<b>Design Case</b>		
<b>Adjustment Case</b>		638'	723'	556'
	10'	\$0.45	\$0.40	\$0.50
	9'	\$0.45	\$0.40	<b>\$0.50</b>

**Additives**

Item	Unit	Cost/Unit	Quantity	Total Cost
Elevator (2000#, 7 stops)	Each	\$178,220	2	\$356,440

A unit cost was compiled for the precast structural members only, using RSMeans.

**Unit Costs**

	Material	Labor	Equipment	Subtotal	Quantity	Total
<b>L Beams</b>						
20"x24"x24'	\$1,582.12	\$119.80	\$74.54	\$1,776.50	62	\$110,143.00
20"x28"x24'	\$1,645.00	\$125.40	\$78.30	\$1,848.70	12	\$22,184.40
20"x32"x32'	\$2,447.00	\$144.00	\$89.30	\$2,680.30	42	\$112,572.60
20"x32"x32'	\$2,566.00	\$150.00	\$93.40	\$2,809.40	8	\$22,475.20
<b>Inverted T</b>						
28"x32"x24'	\$1,899.00	\$144.00	\$89.50	\$2,132.50	9	\$19,192.50
28"x36"x24'	\$1,974.00	\$151.00	\$94.00	\$2,219.00	2	\$4,438.00
<b>Double T's</b>						
24"x8'x58'	\$2,987.00	\$220.40	\$137.00	\$3,344.40	256	\$856,166.40
<b>Columns</b>						
14"x14"x9'	\$423.00	\$229.50	\$141.30	\$793.80	38	\$30,164.40
18"x18"x9'	\$738.00	\$283.50	\$176.85	\$1,198.35	9	\$10,785.15
20"x20"x9'	\$738.00	\$283.50	\$176.85	\$1,198.35	3	\$3,595.05
<b>Total</b>	<b>\$15,100.12</b>	<b>\$1,054.60</b>	<b>\$656.04</b>	<b>\$16,810.80</b>		<b>\$1,191,716.70</b>



Barks Daily from Nitterhouse Concrete Products provided an approximate but more accurate estimate.

Double T's = \$15/sf

L Beams = \$300/lf

Inverted T = \$250/lf

14x14 Column = \$39/lf

18x18 Column = \$273/lf

20x20 Column = \$415/lf

#### Unit Cost by Nitterhouse

	Cost	Unit	Span (ft)	Width (ft)	Subtotal	Quantity	Total
Double T	\$15.00	SF	58	8	\$6,960.00	256	\$1,781,760.00
L Beam	\$250.00	LF	24		\$6,000.00	74	\$444,000.00
L Beam	\$250.00	LF	32		\$8,000.00	50	\$400,000.00
Inverted T	\$300.00	LF	24		\$7,200.00	11	\$79,200.00
14x14	\$39.00	LF	9		\$351.00	38	\$13,338.00
18x18	\$273.00	LF	9		\$2,457.00	9	\$22,113.00
20x20	\$415.00	LF	9		\$3,735.00	2	\$7,470.00
<b>Total</b>							

#### Schedule

RSMeans shows a C-11 crew to perform the work of the precast structural members. A C-11 crew includes:

- 1 Structural Steel Forman
- 6 Structural Steel Workers
- 1 Crane Operator
- 1 Crane Oiler
- 1 Crane

The crew can erect the members in:

- Columns 3.75 days
- Double T's 16 days
- L Beams 5.39 days
- Inverted T 0.48 days

Total erection duration for the structural system is 33 working days.





## Conclusion

The implementation of a parking garage allows for a more sustainable site by eliminating the impervious surfaces. The space that has been freed up can be used for other amenities such as an arboretum or restore habitat, small strip mall or direct access road to Father Hurley Boulevard. The erection time is longer and the structure costs more, but there are other benefits to our environment.



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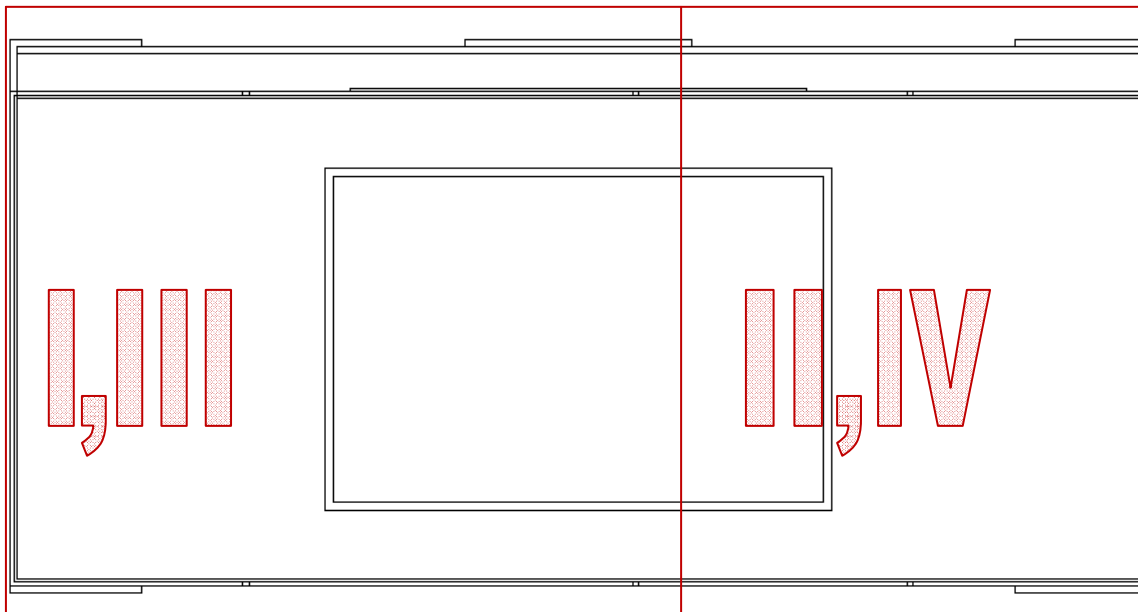
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**Appendix A**  
**Building Sequencing**



BUILDING PLAN



## Appendix B

### Existing Condition Site Plan

Kristen  
Hlopick

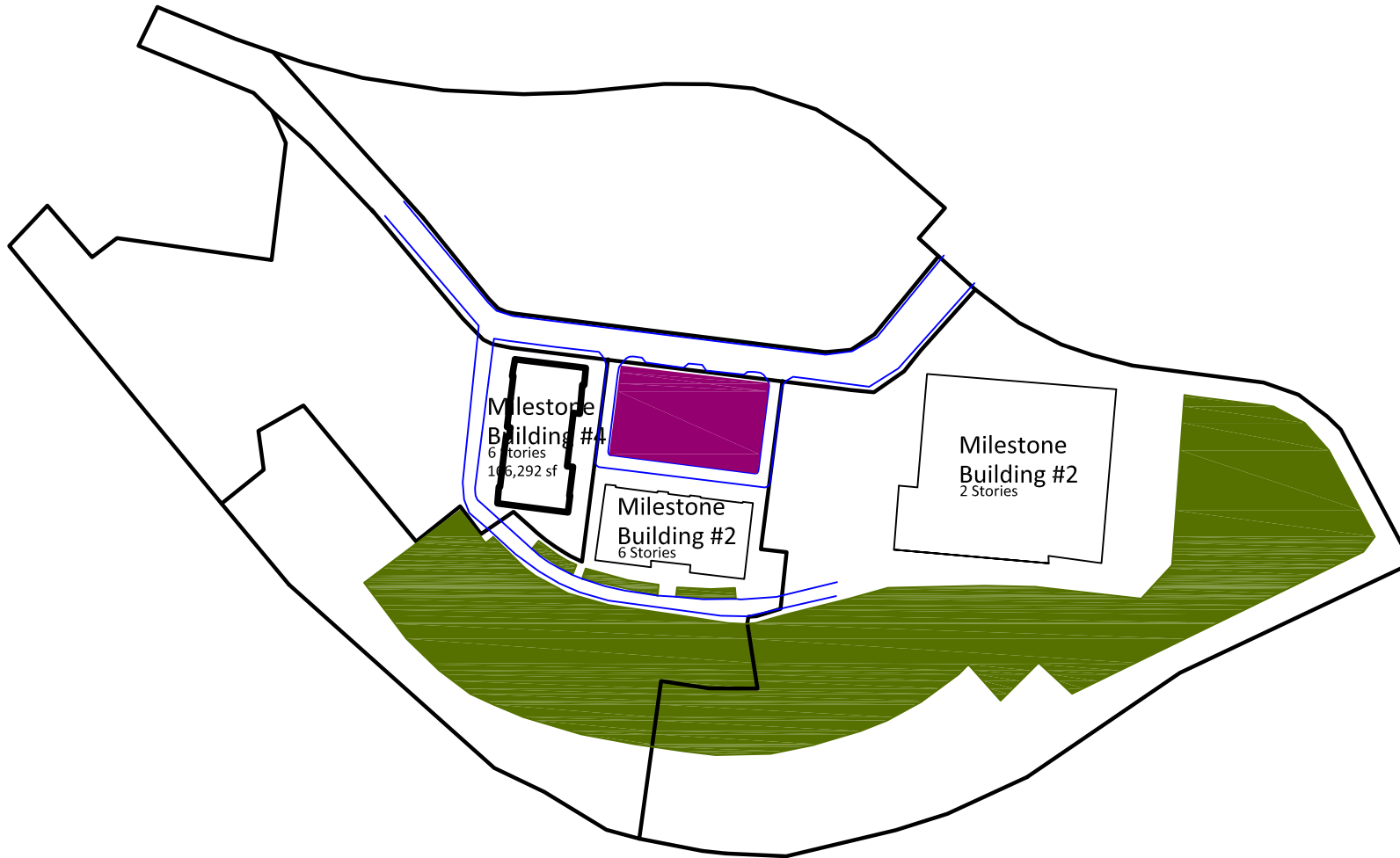
October 5, 2007

Milestone Buisness Park  
Building #4  
Germantown, MD

Revisions

Site Plan  
Existing Condition

Civil-001  
Page 54 of 117



Legend

Courtyard	—	Roads	—
Electric	—	Sanatary Sewer	—
Fence	—	Storm Drain	—
Parking	—	Water Pipe/Struc.	—
Property Line	—		





Kristen Hlopick

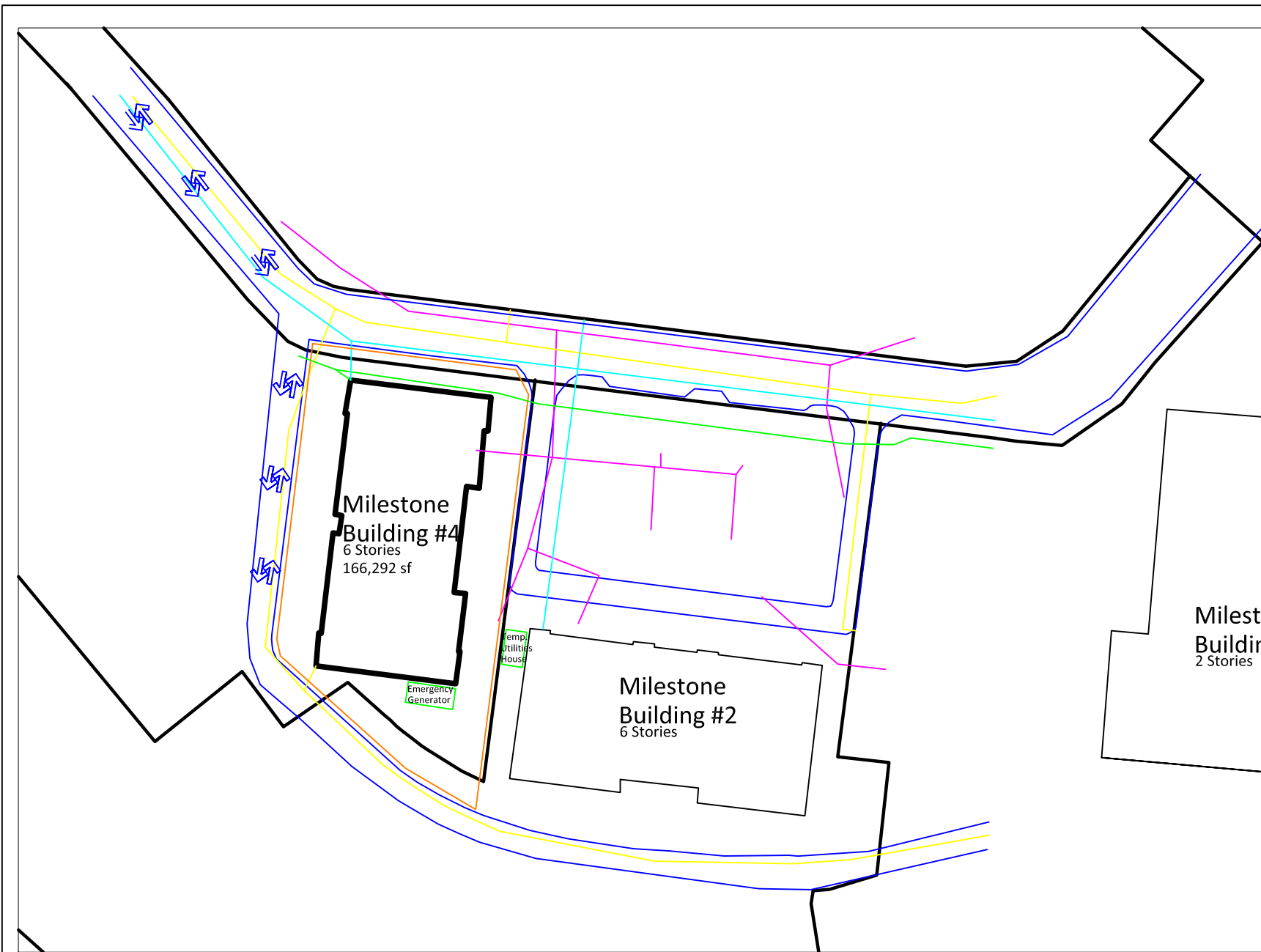
October 5, 2007

Milestone Buisness Park  
Building #4  
Germantown, MD

Revisions

Site Plan  
Existing Condition

Civil-002  
Page 55 of 117



Legend

Courtyard	—	Roads	—
Electric	—	Sanitary Sewer	—
Fence	—	Storm Drain	—
Parking	—	Water Pipe/Struc.	—
Property Line	—		

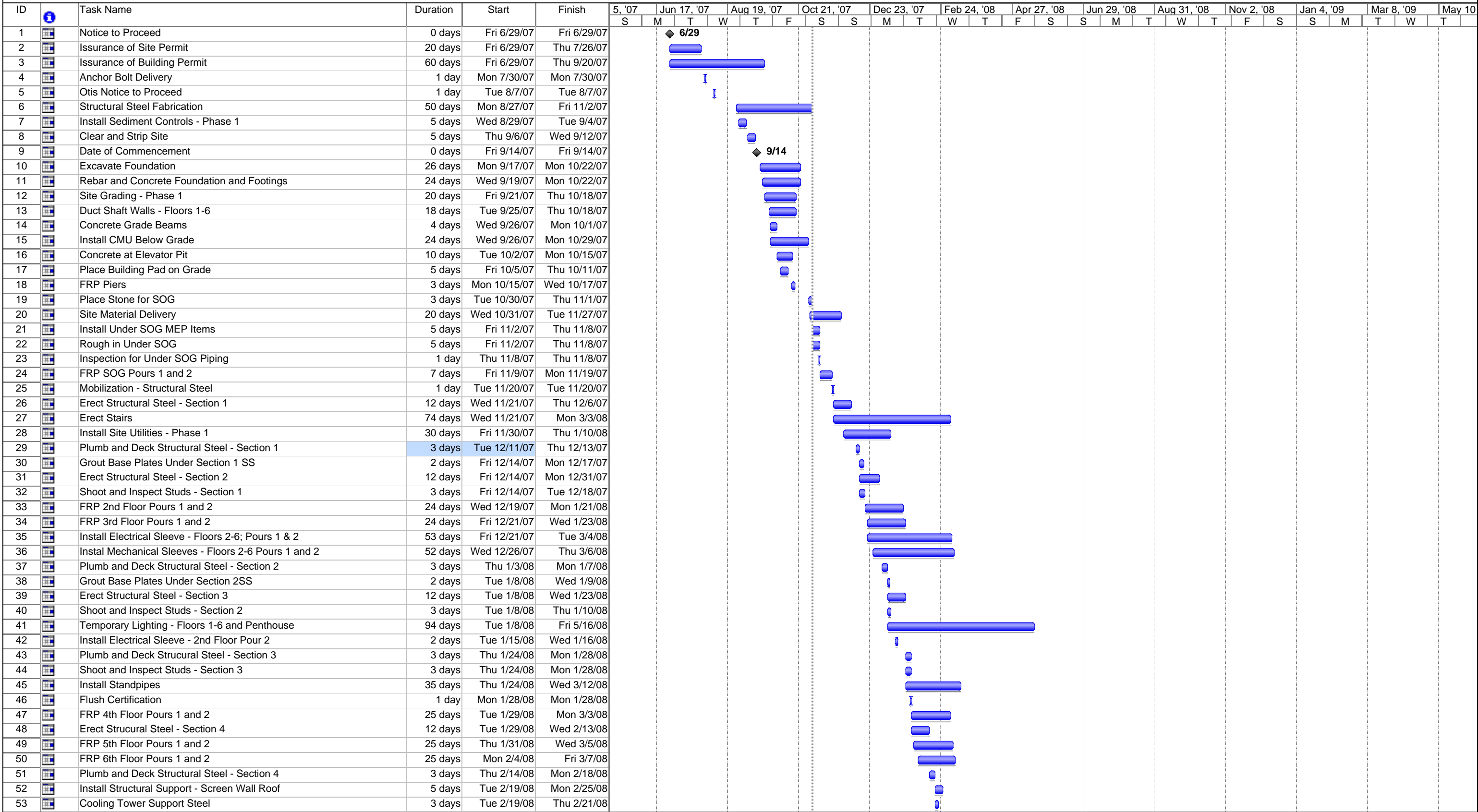




## **Appendix C**

### **Detailed Project Schedule**

Milestone Building #4



# Milestone Building #4

ID	Task Name	Duration	Start	Finish	Schedule																											
					5, '07		Jun 17, '07			Aug 19, '07		Oct 21, '07		Dec 23, '07		Feb 24, '08		Apr 27, '08		Jun 29, '08		Aug 31, '08		Nov 2, '08		Jan 4, '09		Mar 8, '09		May 10		
					S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T		
54	Shoot and Inspect Studs - Section 4	3 days	Tue 2/19/08	Thu 2/21/08																												
55	Set Elev. Equipment into Mechancial Room	1 day	Tue 2/19/08	Tue 2/19/08																												
56	Set Roof Drain Bodies	4 days	Tue 2/19/08	Fri 2/22/08																												
57	Install Roof Curbs - Mechanical	3 days	Tue 2/19/08	Thu 2/21/08																												
58	Set Cooling Tower	2 days	Fri 2/22/08	Mon 2/25/08																												
59	Install Tieback Supports - Roof	5 days	Tue 2/26/08	Mon 3/3/08																												
60	Frame, Sheath - Screen Wall Roof	10 days	Tue 2/26/08	Mon 3/10/08																												
61	FRP Penthouse	4 days	Mon 3/10/08	Thu 3/13/08																												
62	Erect Material Hoist	3 days	Mon 3/10/08	Wed 3/12/08																												
63	Mobilization - Drywall	1 day	Mon 3/10/08	Mon 3/10/08																												
64	Install EIFS - Screen Wall Roof and Penthouse	26 days	Tue 3/11/08	Tue 4/15/08																												
65	Layout Walls - Floors 1-6 and Penthouse	49 days	Tue 3/11/08	Fri 5/16/08																												
66	Layout Equipment Pads and Curbs	1 day	Thu 3/13/08	Thu 3/13/08																												
67	Install Temporary Power for Material Hoist	1 day	Thu 3/13/08	Thu 3/13/08																												
68	Layout Equipment Pad and Curbs	1 day	Thu 3/13/08	Thu 3/13/08																												
69	Frame, Sheath, Moisture Barrier, Masonry Walls - South	8 days	Fri 3/14/08	Tue 3/25/08																												
70	Set SCU's - Floors 1-6 and Penthouse	1 day	Mon 3/17/08	Mon 3/17/08																												
71	Spray Fireproofing - Floors 1-6 and Penthouse	48 days	Tue 3/18/08	Thu 5/22/08																												
72	Set Penthouse Pumps	2 days	Thu 3/20/08	Fri 3/21/08																												
73	Ductwork - Floors 1-6	46 days	Thu 3/20/08	Thu 5/22/08																												
74	Install Duct - Floors 1-6 and Penthouse	54 days	Mon 3/24/08	Thu 6/5/08																												
75	Penthouse Piping	10 days	Mon 3/24/08	Fri 4/4/08																												
76	Frame, Sheath, Moisture Barrier, Masonry Walls - West	13 days	Wed 3/26/08	Fri 4/11/08																												
77	Layout - Masonry	2 days	Thu 3/27/08	Fri 3/28/08																												
78	Install Carriers and Plumbing Rough In - Floors 1-6	46 days	Thu 3/27/08	Thu 5/29/08																												
79	Install and Washdown Masonry - South	18 days	Mon 3/31/08	Wed 4/23/08																												
80	Install Sprinkler System	61 days	Tue 4/1/08	Tue 6/24/08																												
81	Install CMU Loading Dock/General Area	5 days	Thu 4/3/08	Wed 4/9/08																												
82	Install Roof - Main Roof	10 days	Fri 4/4/08	Thu 4/17/08																												
83	Install and Washdown Masonry - West	25 days	Mon 4/14/08	Fri 5/16/08																												
84	Frame, Sheath, Moisture Barrier, Masonry Walls - North	8 days	Mon 4/14/08	Wed 4/23/08																												
85	Install and Washdown Masonry - East	25 days	Fri 4/18/08	Thu 5/22/08																												
86	Install Wood Blocking at Exterior Wall -South	3 days	Mon 4/21/08	Wed 4/23/08																												
87	Install Metal Flashing and Caps - South	3 days	Thu 4/24/08	Mon 4/28/08																												
88	Mobilization - Windows	1 day	Thu 4/24/08	Thu 4/24/08																												
89	Caulk Masonry Joints - South	3 days	Thu 4/24/08	Mon 4/28/08																												
90	Frame, Sheath, Moisture Barrier, Masonry Walls - East	13 days	Thu 4/24/08	Mon 5/12/08																												
91	Install and Caulk Windows - South	20 days	Fri 4/25/08	Thu 5/22/08																												
92	Install and Washdown Masonry - North	18 days	Mon 5/5/08	Wed 5/28/08																												
93	Install Brick Loading Dock/General Area	6 days	Tue 5/6/08	Tue 5/13/08																												
94	Install Roof - Penthouse	5 days	Thu 5/8/08	Wed 5/14/08																												
95	Set Fire Pump and Jockey Pump	2 days	Thu 5/8/08	Fri 5/9/08																												
96	Install Wood Blocking at Exterior Wall - West	3 days	Mon 5/12/08	Wed 5/14/08																												
97	Power to Fire Pump and Jockey Pump	3 days	Mon 5/12/08	Wed 5/14/08																												
98	Loading Dock Ramp Concrete	5 days	Wed 5/14/08	Tue 5/20/08																												
99	Washdown Loading Dock/General Area	2 days	Wed 5/14/08	Thu 5/15/08																												
100	Install Metal Flashing and Caps - West	3 days	Thu 5/15/08	Mon 5/19/08																												
101	Frame and Install GWB Elevator Shaft 3 Sides	20 days	Thu 5/15/08	Wed 6/11/08																												
102	Fire Pump Flow Test	1 day	Thu 5/15/08	Thu 5/15/08																												
103	Sprinkler Final Inspection	1 day	Fri 5/16/08	Fri 5/16/08																												
104	Install and Caulk Windows - West	25 days	Mon 5/19/08	Fri 6/20/08																												
105	Caulk Masonry Joints - West	3 days	Mon 5/19/08	Wed 5/21/08																												
106	Vanity and Toilet Partition Support Steel - Floors 1-6	44 days	Tue 5/20/08	Fri 7/18/08																												

Project: Project1 Date: Fri 11/2/07	Task	Progress	Summary	External Tasks	Deadline
	Split	Milestone	Project Summary	External Milestone	

### Milestone Building #4

ID	Task Name	Duration	Start	Finish	5, '07		Jun 17, '07			Aug 19, '07			Oct 21, '07		Dec 23, '07		Feb 24, '08		Apr 27, '08		Jun 29, '08		Aug 31, '08		Nov 2, '08		Jan 4, '09		Mar 8, '09		May 10			
					S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M
107	Frame Walls and Ceiling - Floors 1-6 and Penthouse	66 days	Tue 5/20/08	Tue 8/19/08																														
108	Plumbing Rough In - Penthouse	5 days	Wed 5/21/08	Tue 5/27/08																														
109	Install Ceramic Tile in RR - Floors 1-6	10 days	Thu 5/22/08	Wed 6/4/08																														
110	Rough In Electrical - Floors 1-6 and Penthouse	61 days	Thu 5/22/08	Thu 8/14/08																														
111	Set Generator	1 day	Fri 5/23/08	Fri 5/23/08																														
112	Install Wood Blocking at Exterior Wall - North	3 days	Mon 5/26/08	Wed 5/28/08																														
113	Set Switchgear	5 days	Tue 5/27/08	Mon 6/2/08																														
114	Electrical Close In Inspection - Penthouse	1 day	Wed 5/28/08	Wed 5/28/08																														
115	FRP Stairs Near B-1 ext	3 days	Thu 5/29/08	Mon 6/2/08																														
116	Install Metal Flashing and Caps - North	3 days	Thu 5/29/08	Mon 6/2/08																														
117	Install and Caulk Windows - North	20 days	Thu 5/29/08	Wed 6/25/08																														
118	Caulk Masonry Joints - North	3 days	Thu 5/29/08	Mon 6/2/08																														
119	Framing Close-in Inspection - Penthouse	1 day	Thu 5/29/08	Thu 5/29/08																														
120	Electrical Close In Inspection - 1st Floor	1 day	Thu 5/29/08	Thu 5/29/08																														
121	Plumbing Wall Close-in Inspection - Floors 1-6	3 days	Fri 5/30/08	Tue 6/3/08																														
122	Install Mirrors - Floors 1-6	58 days	Mon 6/2/08	Wed 8/20/08																														
123	Vanity Tops - Floors 1-6	44 days	Tue 6/3/08	Fri 8/1/08																														
124	TPF Inspection	1 day	Tue 6/3/08	Tue 6/3/08																														
125	Power to Elevator Equipment	3 days	Wed 6/4/08	Fri 6/6/08																														
126	Install Sprinkler Mains - Penthouse	6 days	Fri 6/6/08	Fri 6/13/08																														
127	Plumbing Fixtures - Floors 1-6	47 days	Fri 6/6/08	Mon 8/11/08																														
128	Mobilization - Elevator	2 days	Tue 6/10/08	Wed 6/11/08																														
129	Set Elev. Mechanical Room Equipment for Installation	10 days	Tue 6/10/08	Mon 6/23/08																														
130	Set and Pipe In House Pump	3 days	Tue 6/10/08	Thu 6/12/08																														
131	Framing Close-in Inspection - 1st Floor	1 day	Thu 6/12/08	Thu 6/12/08																														
132	Pipe Out Sprinkler Room	1 day	Fri 6/13/08	Fri 6/13/08																														
133	HVAC Systems Operational	0 days	Fri 6/13/08	Fri 6/13/08																														
134	Install Wood Blocking at Exterior Wall - East	3 days	Mon 6/16/08	Wed 6/18/08																														
135	Install Sprinkler Branch and Heads - Penthouse	6 days	Mon 6/16/08	Mon 6/23/08																														
136	Install Decorated Painted Steel Rails	10 days	Thu 6/19/08	Wed 7/2/08																														
137	Electrical Close In Inspection - 2nd Floor	1 day	Thu 6/19/08	Thu 6/19/08																														
138	Grilles and Diffusers - Floors 1-6	50 days	Thu 6/19/08	Wed 8/27/08																														
139	Framing Close-in Inspection - 2nd Floor	1 day	Fri 6/20/08	Fri 6/20/08																														
140	Install and Caulk Windows - East	25 days	Mon 6/23/08	Fri 7/25/08																														
141	Caulk Masonry Joints - East	3 days	Mon 6/23/08	Wed 6/25/08																														
142	Install Aluminum Louvers	5 days	Mon 6/23/08	Fri 6/27/08																														
143	Rough In Electrical - Lobby	19 days	Mon 6/23/08	Thu 7/17/08																														
144	Install Rails and Shaft - Elevator	20 days	Tue 6/24/08	Mon 7/21/08																														
145	Blinds - Floors 1-6	59 days	Fri 6/27/08	Wed 9/17/08																														
146	Install Electrical Trim -Floors 1-6 and Penthouse	59 days	Fri 6/27/08	Wed 9/17/08																														
147	Install Doors Frames and Hardware - Floors 1-6	37 days	Fri 6/27/08	Mon 8/18/08																														
148	Caulk Louvers	2 days	Mon 6/30/08	Tue 7/1/08																														
149	Set Fixtures/Trim/Connect - Floors 1-6	45 days	Tue 7/1/08	Mon 9/1/08																														
150	Install Metal Flashing and Caps - East	3 days	Thu 7/3/08	Mon 7/7/08																														
151	Electrical Close In Inspection - 3rd Floor	1 day	Thu 7/3/08	Thu 7/3/08																														
152	Framing Close-in Inspection - 3rd Floor	1 day	Mon 7/7/08	Mon 7/7/08																														
153	Final Cleaning - All Floors, Penthouse and Lobby	69 days	Tue 7/8/08	Fri 10/10/08																														
154	Install Metal Flashing and Caps - Penthouse	1 day	Wed 7/9/08	Wed 7/9/08																														
155	Hang and Finish GWB - Floors 1-6	30 days	Wed 7/9/08	Tue 8/19/08																														
156	Install Platforms - Elevator	20 days	Wed 7/9/08	Tue 8/5/08																														
157	Install Millwork	25 days	Thu 7/10/08	Wed 8/13/08																														
158	Wall and Ceiling Inspection - Lobby	2 days	Thu 7/10/08	Fri 7/11/08																														
159	Electrical Close In Inspection - 4th Floor	1 day	Fri 7/18/08	Fri 7/18/08																														

Project: Project1 Date: Fri 11/2/07	<table border="0" style="width: 100%;"> <tr> <td style="width: 50%; border-bottom: 1px solid black;">Task</td> <td style="width: 50%;"></td> </tr> <tr> <td style="border-bottom: 1px solid black;">Split</td> <td></td> </tr> </table>	Task		Split		<table border="0" style="width: 100%;"> <tr> <td style="width: 50%; border-bottom: 1px solid black;">Progress</td> <td style="width: 50%;"></td> </tr> <tr> <td style="border-bottom: 1px solid black;">Milestone</td> <td></td> </tr> </table>	Progress		Milestone		<table border="0" style="width: 100%;"> <tr> <td style="width: 50%; border-bottom: 1px solid black;">Summary</td> <td style="width: 50%;"></td> </tr> <tr> <td style="border-bottom: 1px solid black;">Project Summary</td> <td></td> </tr> </table>	Summary		Project Summary		<table border="0" style="width: 100%;"> <tr> <td style="width: 50%; border-bottom: 1px solid black;">External Tasks</td> <td style="width: 50%;"></td> </tr> <tr> <td style="border-bottom: 1px solid black;">External Milestone</td> <td></td> </tr> </table>	External Tasks		External Milestone		Deadline
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Progress																					
Milestone																					
Summary																					
Project Summary																					
External Tasks																					
External Milestone																					

### Milestone Building #4

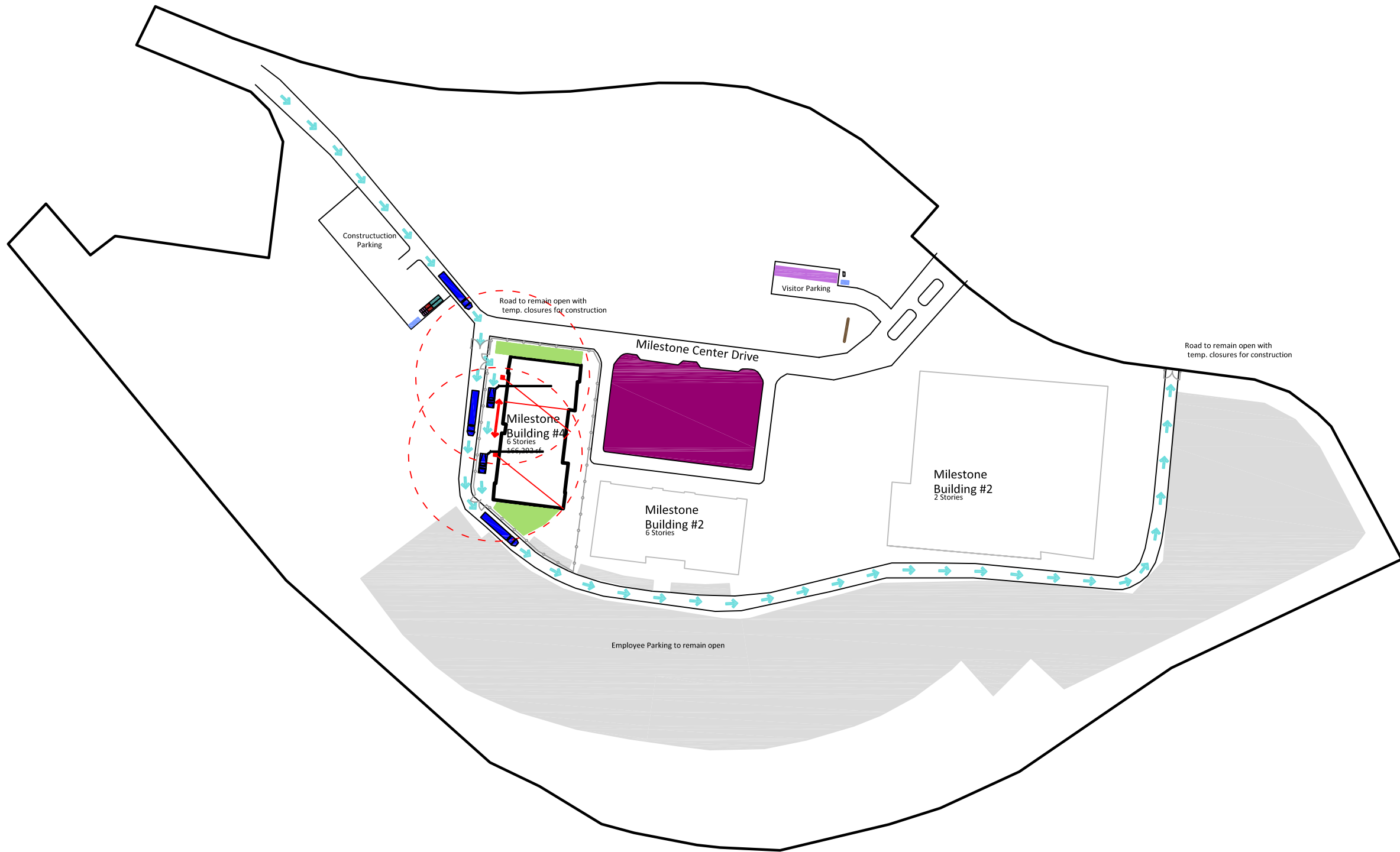
ID	Task Name	Duration	Start	Finish	5, '07		Jun 17, '07			Aug 19, '07			Oct 21, '07		Dec 23, '07		Feb 24, '08			Apr 27, '08			Jun 29, '08			Aug 31, '08			Nov 2, '08		Jan 4, '09		Mar 8, '09		May 10			
					S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	
160	Framing Close-in Inspection - 4th Floor	1 day	Mon 7/21/08	Mon 7/21/08																																		
161	Install Roof - 3rd Floor Ledge	5 days	Tue 7/22/08	Mon 7/28/08																																		
162	Install Sedemint Controls - Phase 2	5 days	Fri 7/25/08	Thu 7/31/08																																		
163	Vestibule Glass Walls and Doors	15 days	Fri 7/25/08	Thu 8/14/08																																		
164	Insulation - Floors 1-6	30 days	Tue 7/29/08	Mon 9/8/08																																		
165	Dismantle Material Hoist	3 days	Thu 7/31/08	Mon 8/4/08																																		
166	Install Site Utilities - Phase 2	20 days	Fri 8/1/08	Thu 8/28/08																																		
167	Set Stone Floor Lobby	20 days	Fri 8/1/08	Thu 8/28/08																																		
168	Electrical Close In Inspection - 5th Floor	1 day	Fri 8/1/08	Fri 8/1/08																																		
169	Framing Close-in Inspection - 5th Floor	1 day	Mon 8/4/08	Mon 8/4/08																																		
170	Erect Spandrel Support Steel - Material Hoist	6 days	Tue 8/5/08	Tue 8/12/08																																		
171	Install/Set Frames - Doors 1-6	10 days	Wed 8/6/08	Tue 8/19/08																																		
172	Install Toilet Partitions and Assc. - Floors 1-6	5 days	Tue 8/12/08	Mon 8/18/08																																		
173	Frame, Sheath, Moisture Barrier, Masonry Walls - Material Hoist	5 days	Wed 8/13/08	Tue 8/19/08																																		
174	Electrical Close In Inspection - 6th Floor	1 day	Fri 8/15/08	Fri 8/15/08																																		
175	Framing Close-in Inspection - 6th Floor	1 day	Mon 8/18/08	Mon 8/18/08																																		
176	Install and Washdown Masonry - Material Hoist	9 days	Wed 8/20/08	Mon 9/1/08																																		
177	Build Cabs - Elevator	15 days	Wed 8/20/08	Tue 9/9/08																																		
178	Build Glass Entry	10 days	Fri 8/22/08	Thu 9/4/08																																		
179	Prime and Paint - Floors 1-6	24 days	Fri 8/22/08	Wed 9/24/08																																		
180	Install and Caulk Windows - Material Hoist	5 days	Thu 9/4/08	Wed 9/10/08																																		
181	Install Doors - Elevator	10 days	Wed 9/10/08	Tue 9/23/08																																		
182	Install F/A Annunciator Panel into Wall	2 days	Tue 9/16/08	Wed 9/17/08																																		
183	Install Building Directory	2 days	Tue 9/16/08	Wed 9/17/08																																		
184	Power to Elevator Sump Pump	2 days	Wed 9/17/08	Thu 9/18/08																																		
185	Install and Pipe In Elevator Sump Pump	2 days	Thu 9/18/08	Fri 9/19/08																																		
186	Final Plumbing Inspection	1 day	Tue 9/23/08	Tue 9/23/08																																		
187	Final Electrical Inspection	1 day	Wed 9/24/08	Wed 9/24/08																																		
188	Test and Adjust Cars	10 days	Wed 9/24/08	Tue 10/7/08																																		
189	Montgomery County Fire Inspection	3 days	Thu 9/25/08	Mon 9/29/08																																		
190	MEP Commissioning	10 days	Tue 10/7/08	Mon 10/20/08																																		
191	Provide Operator for Shaft Point Up Work	3 days	Wed 10/8/08	Fri 10/10/08																																		
192	QEI Elevator Inspection	1 day	Mon 10/13/08	Mon 10/13/08																																		
193	Final State Inspection - Elevator	1 day	Tue 10/14/08	Tue 10/14/08																																		
194	Building Final Inspection	2 days	Wed 10/15/08	Thu 10/16/08																																		
195	C of O From County	3 days	Thu 10/16/08	Mon 10/20/08																																		
196	Substantial Completion and Turnover	0 days	Tue 10/21/08	Tue 10/21/08																																		
197	Contractual Completion	0 days	Fri 11/21/08	Fri 11/21/08																																		

Project: Project1 Date: Fri 11/2/07	Task	Progress	Milestone	Summary	Project Summary	External Tasks	External Milestone	Deadline
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**Appendix D**  
**Site Utilization Plan**

Milestone Buisness Park  
 Building #4  
 Germantown, MD



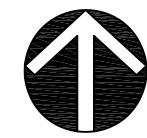
Revisions

Site Utilization

Steel  
 Erection

Legend

Concrete Trucks	Delivery Path	Portable Toilets
Construction Parking	Delivery Trucks	Property Line
Courtyard	Dumpsters	Recycle Bins
Crane	Fence	SEA Trailers
Crane Path	Parking	Steel Staging





Constructuon Parking

Road to remain open with temp. closures for construction

Crane; II, IV

Milestone Building #4

Crane; I, III

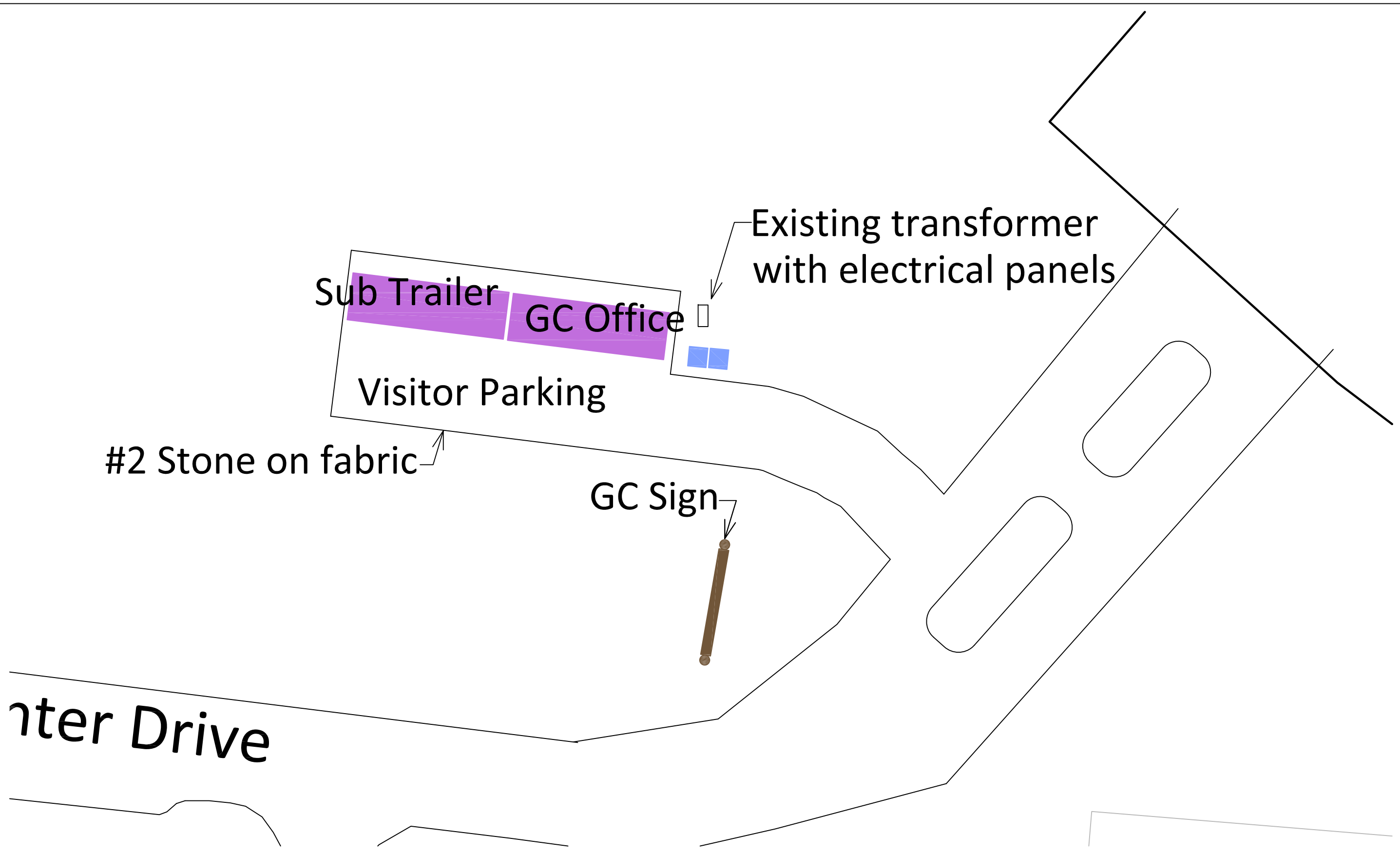
Milestone Center Dr

Milestone Building #2  
6 Stories

Legend

Concrete Trucks	Delivery Path	Portable Toilets
Construction Parking	Delivery Trucks	Property Line
Courtyard	Dumpsters	Recycle Bins
Crane	Fence	SEA Trailers
Crane Path	Parking	Steel Staging





#2 Stone on fabric

Sub Trailer GC Office

Visitor Parking

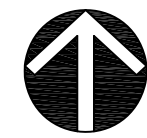
Existing transformer with electrical panels

GC Sign

Center Drive

Legend

Concrete Trucks	Delivery Path	Portable Toilets
Construction Parking	Delivery Trucks	Property Line
Courtyard	Dumpsters	Recycle Bins
Crane	Fence	SEA Trailers
Crane Path	Parking	Steel Staging





**Appendix E**  
**Survey Consultant Package**



## **Appendix E.1**

### **Introduction Letter**



Construction Management | Dr. Riley | Germantown, Maryland | April 9, 2008

Dear Sir or Madam;

I am currently a senior at The Pennsylvania State University majoring in Architectural Engineering with an emphasis in Construction Management. As I approach graduation, one requirement is to write a thesis. Through my studies and experience, I have found that some projects had to take away LEED points early during construction because of cost, availability of materials, trades, and knowledge deficit within the construction industry. After speaking with industry members, I found that many other companies, when implementing LEED design into a project for the first time, have experienced similar problems.

My research looks into creating a LEED guide for trade contractors that will allow for an easy implementation process for inexperienced industry members on preselected Materials and Resources points. An information pamphlet and LEED guidelines will be developed for them. The goal of my research is to enable companies to prepare a proficient project team early on.

LEED design is a hot topic in today's industry and you can't go a day without hearing about green, sustainability or energy efficient. After graduation, I will be working with construction teams in and around the nation's capital. The city's master plan calls for all new construction to be LEED certified. With this in mind, I developed my research topic. To achieve this goal, trade contractors must be prepared to implement LEED changes into their projects. Once proficient with LEED concepts, contractors will benefit by being called back for future jobs.

I have enclosed three documents. The first is a LEED information sheet. This sheet focuses on three Materials and Resource credits (MR2, MR4 and MR5) and provides background and highlights for each of the credits. The second document is a survey. The intention of this survey is to provide feedback on your feelings about the situation, any additional advice, and most importantly to help narrow down my research to a more specific topic. The third document is a LEED guideline for trade contractors that provides the documents needed for common specification sections.

I would greatly appreciate your input and feedback on LEED design and construction to support my senior thesis research. Due to deadlines my professors have set, I would like to receive feedback by **Friday March 28, 2008**. Should you have any questions or concerns, please feel free to contact me at your convenience.

Sincerely,  
Kristen M Hlopick



**Appendix F.2**  
**Opinion Survey**



Construction Management | Dr. Riley | Germantown, Maryland | April 9, 2008

**SECTION 1**

What kind of company do you work for?

- Owner
- Architect
- Construction Manager
- General Contractor
- Trade Contractor
- Supplier
- Manufacturer
- Other: \_\_\_\_\_

Have you participated in the design or construction of a LEED certified building?

- Yes. Please proceed to SECTION 2
- No. Please proceed to SECTION 3

**SECTION 2**

How many LEED certified building did you take part in?

What were the ratings?

- Certified
- Silver
- Gold
- Platinum

If you are a trade partner, supplier or manufacturer, did you have any problems implementing the needed requirements for the anticipated LEED points: MR 2 (Construction Waste Management), MR 4(Recycled Content), MR 5(Local/Regional Materials)?

- Yes
- No

If yes, please provide explanation.

Was there any trouble obtaining verification information needed for submittals?

- Yes
- No

If yes, please provide explanation.

When fulfilling requirements for MR 2 Construction Waste Management, what method was used?

- third party to separate co-mingled trash
  - separate recycling bins on site for different materials
- Why did you choose this method?



Construction Management | Dr. Riley | Germantown, Maryland | April 9, 2008

Where there any complications?

Did you have any trouble finding products with the noted recycled content in MR4 Recycled Content?

Yes

No

If yes, please provide explanation.

Was there any trouble finding local materials, suppliers and/or manufacturers for MR 5 Local Materials?

Yes

No

If yes, please provide explanation.

### SECTION 3

Would your company be interested in pursuing a LEED project?

Yes

No

If yes, are you looking to start a LEED project?

If no, please provide explanation.

Do you feel that you have adequate knowledge of the LEED design and construction?

Yes

No

Please provide explanation.

What factors do you feel that have preventing your company from taking part in a LEED project?

### SECTION 4

Was the LEED implementation process successful?

Yes

No

Please provide explanation.





For trade contractors, was this your first LEED project?

Yes

No

If yes, did you find that when implementing the LEED process for the first time, that you had trouble with any of the requirements?

Do you feel that a LEED guide made for trade contractors would be beneficial when implementing LEED into a construction project?

Yes

No

Do you have any suggestions for what can make this process smoother?

As a trade contractor, do you have your own thoughts about recycling materials that is not mentioned in the LEED guidelines?

What benefits have you seen in the LEED projects? Are you happy with your decision in taking part of a LEED project?

Please feel free to add any additional comments.

Thank you for your time and input. Your participation in my senior thesis research is greatly appreciated. Should you have any questions, feel free to contact me.

Kristen M Hlopick  
825 South Allen Street, #8  
State College, PA 16801  
[kmh326@psu.edu](mailto:kmh326@psu.edu)  
[khlopick@buchconstruction.com](mailto:khlopick@buchconstruction.com)  
814.282.5431



### **Appendix E.3**

#### **LEED Information Pamphlet**



## **MR 2 – Construction Waste Management**

### Requirements:

- Recycle or salvage 50% of non-hazardous construction and demolition debris
- Develop and implement a construction waste management plan
- Determine whether the materials will be sorted on site or comingled

### Strategies:

- Cardboard, metal brick, acoustical ceiling tile, concrete, plastic, clean wood, glass, drywall, carpet and insulation
- Designate area on site for recycling and track construction process
- Identify construction handlers and haulers

### Calculations:

None

### Pre Certification Submittal Documentation:

- Narrative describing how the project intends to accomplish the credit requirements
- Confirmation of this intent from both the design professional and the owner/developer

### Certification Submittal Documentation:

- Complete the construction waste calculation tables in the submittal template
  - General description of each type of waste generated
  - Location of receiving agent (recycler or landfiller) for waste
  - Quantity of waste diverted (by category) in tons or cubic yards
- Narrative describing the project construction waste management approach
  - Construction waste management plan
  - Addition comments/note for special circumstances



**MR 2 Construction Waste Management – Sample Tables**

Sample Construction Waste Management Diversion Summary

<b>Diverted/Recycled Materials Description</b>	<b>Diversion/Recycling Hauler or Location</b>	<b>Quantity of Diverted/ Recycled Waste</b>	<b>Units (tons/cy)</b>
Concrete	ABC Recycling	138.0	Tons
Wood	Z-Construction Reuse	10.2	Tons
Gypsum Wallboard	ABC Recycling	6.3	Tons
Steel	Re-Cycle Steel Collectors	1.1	Tons
Crushed Asphalt	On-Site Reuse	98.2	Tons
Masonry	ABC Recycling	6.8	Tons
Cardboard	ABC Recycling	1.6	Tons
<b>TOTAL CONSTRUCTION WASTE DIVERTED</b>		<b>262.2</b>	<b>Tons</b>
<b>Landfill Materials Description</b>	<b>Landfill Hauler or Location</b>	<b>Quantity of Diverted/ Recycled Waste</b>	<b>Units (tons/cy)</b>
General Mixed Waste	XYZ Landfill	52.3	Tons
<b>TOTAL CONSTRUCTION WASTE SENT TO LANDFILL</b>		<b>52.3</b>	<b>Tons</b>
<b>TOTAL OF ALL CONSTRUCTION WASTE</b>		<b>314.5</b>	<b>Tons</b>
<b>PERCENTAGE OF CONSTRUCTION WASTE DIVERTED FROM LANDFILL</b>		<b>83.40%</b>	

Solid Waste Conversion Factors

<b>Material</b>	<b>Density (lbs/cy)</b>
Cardboard	100
Gypsum Wallboard	500
Mixed Waste	350
Rubble	1400
Steel	1000
Wood	300



## MR 4 – Recycled Content

### Requirements:

Use materials such that the sum of post-consumer recycled content plus one half of the pre-consumer content constitutes at least 10% of the total value of materials (base on cost).

### Strategies:

- Identify material suppliers that can achieve predetermined goal
- During construction, ensure correct products are being installed
- Consider range of environmental, economic and performance attributes when selecting products and materials
- Metals, concrete, masonry, acoustical ceiling tile, carpet, ceramic tile, insulation

### Calculations:

Recycled content value =

(% post consumer\*material cost) + 0.5(% pre construction\*material cost)

% recycled content =  $\frac{\text{total recycled content material value (\$)}}{\text{total material cost (\$)}}$

Total material costs = actual costs in CSI Divisions 2-10

= total material cost\*45% (default)

Steel:

- Assume 25% post consumer, but actual may be much higher

Assemblies:

- Consider % by weight for pre and post consumer products
- When there are subcomponents, the final two percentages must be determined by using the weights of the small subcomponent element

Supplementary Cementitious Material:

- Calculate recycled content value on the mass of the cementitious material only, not the entire concrete mix.
- Amount of cementitious material can be obtained from supplier

### Pre Certification Submittal Documentation:

- Narrative describing how project intends to accomplish credit
- Confirmation of this intent from both the design professional and the owner/developer



**Certification Submittal Documentation:**

- Provide total materials cost (CSI Division 2-10) or 45% of the total project material cost (CSI Division 2-10)
- Provide tabulation of each material used on the project that is being tracked for recycled content
  - Material
  - Manufacturer
  - Product cost
  - Pre/Post consumer amount
  - Source of recycled content data
- Narrative for any special circumstances

**MR 4 Recycled Content – Sample Tables**

Sample Supplementary Cementitious Material Calculations

Mix #	Mass of Portland cement* (lbs)	Mass of recycled SCMs (lbs)	Mass of total cementitious materials (lbs)	SCMs as a percentage of total cementitious materials (%)	Dollar value of all cementitious materials (from concrete supplier)	Recycled content value per yard [(SCM/2)x dollar value]
2	200	50	250	20%	\$35	\$3.50
3	300	100	400	25%	\$45	\$5.63

*\*This column also includes any other cementitious ingredients that are not recycled.*



## MR 5 – Regional Materials

### Requirements:

Use building material that have been extracted, harvested or recovered, as well as manufactured within 500 miles from project site. If only a fraction of the material is extracted, harvested or manufactured, only use that fraction in the calculations.

### Strategies:

- Research early in design process. Select feasible materials.
- Establish a goal and only specify materials that can be found locally
- Run preliminary calculations (design phase) to ensure target
- Ensure locate materials that are being installed
- Quantify local materials that are being installed
- When selecting materials consider wide range of environmental, economic and performance attributes
- General contractor should work with trade contractors and suppliers to verify available materials
- General contractors are responsible for documenting amounts and values of materials

### Calculations:

$$\% \text{ local materials} = \frac{\text{Total cost of local materials (\$)}}{\text{total material cost (\$)}}$$

$$\begin{aligned} \text{Total material costs} &= \text{actual costs in CSI Divisions 2-10} \\ &= \text{total material cost} * 45\% \quad (\text{default}) \end{aligned}$$

### Pre Certification Submittal Documentation:

- Narrative describing how the project intends to accomplish credit
- Confirmation of this intent from design professional and owner/developer



**Certification Submittal Documentation:**

- Provide the project’s total cost or total materials cost (CSI Division 2-10)
- Complete the regional materials calculation table – Submittal Template.
  - Product name
  - Material manufacturer
  - Product cost
  - Percentage of product by weight that meets by the manufacturer and extractor criteria
  - Distance between project site and where the location of where the material was harvest, extracted or recovered
  - Distance between project site ad where the location of the manufacturer
- Narrative for any special circumstances

**MR 5 Local/Regional Materials – Sample Tables**

Sample Assembly Percent Regionally Extracted Calculation for Concrete

<b>Components</b>	<b>Weight (lbs)</b>	<b>Distance between Project &amp; Extraction Site (miles)</b>	<b>Weight Contributing to Regional Extraction (lbs)</b>
Cement	282	1,250	0
Fly Ash	282	125	282
Water	275	1	275
Slag	750	370	750
Recycled Concrete & Aggregate	1,000	8	1,000
Sand	1,200	18	1,200
Component Totals	3,789		3,507
<b>Percent Regionally Extracted Materials (3,507/3,789)</b>			<b>92.60%</b>





**MR 5 Local/Regional Materials – Sample Tables (continued...)**

Sample MR Credit 5 Calculation

<b>Product</b>	<b>Manufacturer</b>	<b>Distance Between Project &amp; Manufacturer (mi)</b>	<b>Distance Between Project &amp; Extraction/ Harvest (mi)</b>	<b>Product Cost (\$)</b>	<b>Value Qualifying as Regional</b>	<b>Information Source</b>
Plant material	Green's Landscape	5	5	\$6,770	\$6,770	contractor submittal
Concrete aggregate	Joe's Concrete	15	15	\$21,000	\$21,000	contractor submittal
Insulation	UR Warm	105	1,080	\$9,250	-	product cut sheet
Gypsum board	Gypsum R Us	75	288	\$8,550	\$8,550	letter from manufacturer
Carpet	Fiber Good	355	721	\$15,333	-	
Casework	Top Counter	18	320	\$12,200	\$12,200	contractor submittal
Lumber	My Mill	110	320	\$38,990	\$38,990	contractor submittal
Wood doors	Closeby	71	320	\$7,000	\$7,000	contractor submittal
<b>Total Cost of Regional Materials</b>					<b>\$94,510</b>	
<b>Total Materials Cost (Divisions 2-10)</b>					<b>\$751,000</b>	
<b>Percent Regional Materials</b>					<b>13%</b>	
<b>Points Earned</b>					<b>1</b>	



## **Appendix E.4**

### **LEED Introduction Letter**



### LEED Guidelines for Trade Contractors

There are three documents that compile the LEED Guidelines for Trade Contractors: Submittals, Design Requirement and Waste Management. With each document there are five (5) tabs, which can be found at the bottom left.

The first tab provides a matrix with the specification sections across the top and the respective requirements across the left side. I have already placed an “X” in some boxes where I felt this could be a common place. This guide is meant to be project specific. Therefore, more rows and columns can be added or deleted and the X’s can be changed. With that said, this matrix can become very large and hard to read.

The next two tabs provide a list of the requirements for each specification section and requirement (submittal, design requirement or waste management). The following two tabs, provides a neater version of the previous tabs. Once you review the guide, please answer the following questions.

Was this guide easy to understand?

Yes

No

Please provide explanation.

Was it user friendly?

Yes

No

Please provide explanation.

Did you find it helpful?

Yes

No

Please provide explanation.

Do you have any suggestions as to how this guide can be improved?

Feel free to contact me with any questions. Thank you for your participation in my senior thesis research.

Kristen



**Appendix E.5**  
**Submittal Requirements**  
**Matrix and List**





**Arranged by Specifications**

**S.1 01 7419 Construction Waste Management and Disposal**  
 LEED letter template for Credit MR 2.1 and Credit MR 2.2, signed by contractor, tabulating total waste material, quantities diverted and means by which it is diverted and statement that requirements for the credit have been met.

**S.2 03 2000 Concrete Reinforcing**  
 Submit certification/letter from material supplier(s) indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content for Credit MR 4  
 Provide documentation identifying manufacturer and extraction, harvest, and/or recover location of materials provided under this section for Credit MR 5

**S.3 03 3000 CIP Concrete**  
 Submit certification/letter from material supplier(s) indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content for Credit MR 4  
 Provide documentation identifying manufacturer and extraction, harvest, and/or recover location of materials provided under this section for Credit MR 5

**S.4 03 4500 Precast Architectural Concrete**  
 Submit certification/letter from material supplier(s) indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content for Credit MR 4  
 Provide documentation identifying manufacturer and extraction, harvest, and/or recover location of materials provided under this section for Credit MR 5

**S.5 04 0510 Masonry Mortaring and Grouting**  
 Submit certification/letter from material supplier(s) indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content for Credit MR 4  
 Provide documentation identifying manufacturer and extraction, harvest, and/or recover location of materials provided under this section for Credit MR 5

**S.6 04 2000 Unit Masonry**  
 Submit certification/letter from material supplier(s) indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content for Credit MR 4  
 Provide documentation identifying manufacturer and extraction, harvest, and/or recover location of materials provided under this section for Credit MR 5



**Arranged by Submittal Requirements**

**LEED letter template for Credit MR 2.1 and Credit MR 2.2, signed by contractor, tabulating total waste material, quantities diverted and means by which it is diverted and statement that requirements for the credit have been met.**

**CS.1**

S.1	01 7419	Construction Waste Management and Disposal
-----	---------	--

**Submit certification/letter from material supplier(s) indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content for Credit MR 4**

**CS.2**

S.2	03 2000	Concrete Reinforcing
S.3	03 3000	CIP Concrete
S.4	03 4500	Precast Architectural Concrete
S.5	04 0510	Masonry Mortaring and Grouting
S.6	04 2000	Unit Masonry
S.7	04 7313	Calcium Silicate Building Stone
S.8	05 1200	Structural Steel Framing
S.9	05 3100	Steel Decking
S.10	05 4000	Cold-Formed Metal Framing
S.11	05 5000	Metal Fabrications
S.12	05 5100	Metal Stairs
S.13	05 5200	Metal Railings
S.14	05 7313	Tempered Glass Railings
S.15	06 1053	Misc. Rough Carpentry
S.16	06 1643	Gypsum Sheathing
S.17	06 6400	Architectural Woodwork
S.18	07 1616	Building Insulation
S.19	07 1616	Cementitious Waterproofing
S.20	07 2100	Thermal Insulation
S.21	07 4220	Metal Panels
S.22	07 4263	Insulated Metal Wall Panels
S.23	07 5400	Thermoplastic Membrane Roofing
S.24	07 8116	Cementitious Fireproofing

S.25	08 1113	Hollow Metal Doors and Frames
S.26	08 1416	Flush Wood Doors
S.27	08 3100	Access Doors and Panels
S.28	08 4226	All-Glass Entrances
S.29	08 4313	Aluminum-Framed Openings
S.30	08 5113	Aluminum Windows
S.31	08 8100	Glass Glazing
S.32	08 9100	Metal Wall Louvers
S.33	09 2116	Gypsum Board Assemblies
S.34	09 3100	Thin-Set Tiling
S.35	09 5100	Acoustical Ceiling
S.36	09 5423	Metal Ceilings
S.37	09 5426	Wood Ceilings
S.38	09 6500	Resilient Flooring
S.40	09 6813	Carpet Tiles
S.41	09 6816	Carpet
S.42	09 7200	Wall Coverings
S.46	10 2113	Toilet Compartments
S.47	10 2813	Toilet Accessories
S.48	10 4400	Fire Protection Specialties
S.49	10 5113	Metal Lockers
S.50	12 2100	Window Blinds
S.52	12 4813	Entrance Floor Mats

**Provide documentation identifying manufacturer and extraction, harvest, and/or recover location of materials provided under this section for Credit MR 5**

**CS.3**

S.2	03 2000	Concrete Reinforcing
S.3	03 3000	CIP Concrete
S.4	03 4500	Precast Architectural Concrete
S.5	04 0510	Masonry Mortaring and Grouting
S.6	04 2000	Unit Masonry
S.7	04 7313	Calcium Silicate Building Stone
S.8	05 1200	Structural Steel Framing
S.9	05 3100	Steel Decking
S.10	05 4000	Cold-Formed Metal Framing
S.11	05 5000	Metal Fabrications

**\*\*\*Full versions can be found on the CD.\*\*\***



**Appendix E.6**  
**Design Requirements**  
**Matrix and List**



## Design Requirements

		S.1	S.2	S.3	S.4	S.5	S.6	S.7	S.8	S.9	S.10	S.11	S.12	S.13	S.14	S.15	S.16	S.17	S.18	S.19	S.20	S.21	S.22	S.23	S.24	S.25	S.26	S.27	S.28	S.29	S.30	S.31	S.32	S.33	S.34	S.35	S.36	S.37	S.38	S.39	S.40	S.41	S.42	S.43	S.44	S.45	S.46	S.47	S.48						
		03 3000	03 4500	04 0510	04 2000	04 2000	04 7313	05 1200	05 3100	05 4000	05 5000	05 5100	05 5200	05 7313	06 1643	06 1643	06 6400	07 2110	07 1616	07 2100	07 4220	07 8116	07 8400	08 1113	08 1416	08 3100	08 4226	08 4313	08 5113	08 8100	08 9100	09 2116	09 2116	09 2116	09 2116	09 3100	09 5100	09 5423	09 5426	09 6500	09 6713	09 6813	09 6816	09 7200	10 2813	10 4400	10 5113	12 2100	12 4813						
DR.1	Materials shall be manufactured and of raw materials extracted within 500 miles of project site.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
DR.2	Provide products from manufacturers with program for reclaiming construction scrap, waste materials, and packaging.									X		X		X	X	X				X			X	X				X			X	X	X								X	X	X	X	X	X	X	X	X	X					
DR.3	Provide materials with recycled content such that sum of post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 10% to 20%.			X															X		X	X					X																												
DR.4	Provide materials with recycled content such that sum of post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 10% to 25%.	X																																																					
DR.5	Provide materials with recycled content such that sum of post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 15% to 25%.																																														X								
DR.6	Provide materials with recycled content such that sum of post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 15% to 50%.																			X			X				X			X																									
DR.7	Provide material with recycled content such that sum of post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 15% to 75%.																											X	X																X	X	X	X	X	X	X				
DR.8	Provide materials with recycled content such that sum of post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 25% to 50%.	X		X	X	X																																													X				
DR.9	Provide materials with recycled content such that sum of post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 25% to 75%.																																																						
DR.10	Provide materials with recycled content such that sum of post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 50% to 75%.						X	X	X	X	X	X	X																																		X								
DR.11	Provide materials with recycled content such that sum of post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 50% to 100%.													X																																									
DR.12	Provide materials with recycled content such that sum of post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 30%.																								X																														
DR.13	Provide materials with recycled content such that sum of post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 50%.																																																						
DR.14	Provide materials with recycled content such that sum of post-consumer recycled content plus one-half pre-consumer recycled content not less than 95%.														X																																								
DR.15	Particleboard materials shall be made with recycled content such that sum of post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 100%.																								X																														
DR.16	Provide materials with recycled content such that sum of post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 100% post-consumer recycled content																																																						
DR.17	Provide materials with recycled content such that sum of post-consumer recycled content plus one-half pre-consumer recycled content is at highest level that is readily available recycled content														X	X	X																																						
DR.18	Materials used in manufacture of clay brick may incorporate contaminated waste that is neutralized or otherwise rendered inert by a manufacturing process that does not discharge additional pollutants.			X																																																			
DR.19	Materials used in manufacture of masonry CMU shall incorporate bottom ash, fly ash, and recycled aggregate.				X																																																		



**Arranged by Specification Section**

**S.1 03 3000 CIP Concrete**

Materials shall be manufactured and of raw materials extracted within 500 miles of project site.
Provide materials with recycled content such that sum of post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 10% to 25%.

**S.2 03 4500 Precast Architectural Concrete**

Materials shall be manufactured and of raw materials extracted within 500 miles of project site.
Provide materials with recycled content such that sum of post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 25% to 50%.

**S.3 04 0510 Masonry Mortaring and Grouting**

Materials shall be manufactured and of raw materials extracted within 500 miles of project site.
Provide materials with recycled content such that sum of post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 10% to 20%.

**S.4 04 2000 Unit Masonry - Brick**

Materials shall be manufactured and of raw materials extracted within 500 miles of project site.
Provide materials with recycled content such that sum of post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 25% to 50%.
Materials used in manufacture of clay brick may incorporate contaminated waste that is neutralized or otherwise rendered inert by a manufacturing process that does not discharge additional pollutants.

**S.5 04 2000 Unit Masonry - CMU**

Materials shall be manufactured and of raw materials extracted within 500 miles of project site.
Provide materials with recycled content such that sum of post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 25% to 50%.
Materials used in manufacture of masonry CMU shall incorporate bottom ash, fly ash, and recycled aggregate.

**S.6 04 7313 Calcium Silicate Building Stone**

Materials shall be manufactured and of raw materials extracted within 500 miles of project site.
Provide materials with recycled content such that sum of post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 25% to 50%.



**Arranged by Design Requirements**

**Materials shall be manufactured and of raw materials extracted within 500 miles of project site.**

**DR.1**

S.1	03 3000	CIP Concrete
S.2	03 4500	Precast Architectural Concrete
S.3	04 0510	Masonry Mortaring and Grouting
S.4	04 2000	Unit Masonry - Brick
S.5	04 2000	Unit Masonry - CMU
S.6	04 7313	Calcium Silicate Building Stone
S.7	05 1200	Structural Steel Framing
S.8	05 3100	Steel Decking
S.9	05 4000	Cold-Formed Metal Framing
S.10	05 5000	Metal Fabrications
S.11	05 5100	Metal Stairs
S.12	05 5200	Metal Railings
S.13	05 7313	Tempered Glass Railings
S.14	06 1643	Gypsum Sheathing - Synthetic Gypsum
S.15	06 1643	Gypsum Sheathing - Gypsum
S.18	07 1616	Cementitious Waterproofing
S.19	07 2100	Thermal Insulation
S.20	07 4220	Metal Panels
S.21	07 8116	Cementitious Fireproofings
S.22	07 8400	Firestopping
S.23	08 1113	Hollow Metal Doors and Frames
S.24	08 1416	Flush Wood Doors
S.25	08 3100	Access Doors and Panels
S.26	08 4226	All-Glass Entrances
S.27	08 4313	Aluminum-Framed Openings
S.28	08 5113	Aluminum Windows
S.29	08 8100	Aluminum Windows
S.30	08 9100	Metal Wall Louvers
S.31	09 2116	Gypsum Board Assemblies - GWB
S.32	09 2116	Gypsum Board Assemblies - Shaft Wall
S.33	09 2116	Gypsum Board Assemblies - Steel Partition & Soffit Framing

S.34	09 2116	Gypsum Board Assemblies - Steel Suspended Ceiling & Soffit Framing
S.35	09 3100	Thin-Set Tiling
S.36	09 5100	Acoustical Ceiling
S.37	09 5423	Metal Ceilings
S.38	09 5426	Wood Ceilings
S.39	09 6500	Resilient Flooring
S.40	09 6713	Elastomeric Flooring
S.41	09 6813	Carpet Tiles
S.42	09 6816	Carpet
S.43	09 7200	Wall Coverings
S.44	10 2813	Toilet Accessories
S.45	10 4400	Fire Protection Specialties
S.46	10 5113	Metal Lockers
S.47	12 2100	Window Blinds
S.48	12 4813	Entrance Floor Mats

**Provide products from manufacturers with program for reclaiming construction scrap, waste materials, and packaging.**

**DR.2**

S.9	05 4000	Cold-Formed Metal Framing
S.11	05 5100	Metal Stairs
S.13	05 7313	Tempered Glass Railings
S.14	06 1643	Gypsum Sheathing - Synthetic Gypsum
S.15	06 1643	Gypsum Sheathing - Gypsum
S.19	07 2100	Thermal Insulation
S.22	07 8400	Firestopping
S.23	08 1113	Hollow Metal Doors and Frames
S.27	08 4313	Aluminum-Framed Openings
S.31	09 2116	Gypsum Board Assemblies - GWB
S.32	09 2116	Gypsum Board Assemblies - Shaft Wall
S.33	09 2116	Gypsum Board Assemblies - Steel Partition & Soffit Framing
S.35	09 3100	Thin-Set Tiling
S.36	09 5100	Acoustical Ceiling
S.41	09 6813	Carpet Tiles
S.42	09 6816	Carpet
S.43	09 7200	Wall Coverings

**\*\*\*Full versions can be found on the CD.\*\*\***



**Appendix E.7**  
**Construction Waste Management**  
**Matrix and List**







**Arranged by Specification Sections**

**S.1 02 4119 Earthwork**

Separate and handle general construction waste in compliance with Waste Management Plan

**S.2 02 4119 Selective Demolition**

Demolition shall be performed in a manner that maximizes salvage and recycling of materials and includes dismantling and removal of materials. Materials dismantled and removed shall be separated, set aside, prepared for reuse, and stored or delivered to collection point for reuse to maximum extent economically feasible.

Items listed below have unique or regulated disposal requirements and are to be removed and disposed of in manner dictated by law or in most environmentally responsible manner. Typical concerns are listed in parentheses:

- a. Fluorescent light ballast manufactured prior to 1978 (PCB)
- b. Fluorescent lamps (mercury)
- c. Refrigeration, air-conditioning, and other equipment containing refrigerants (CFC recovery)
- d. Batteries (Lead, acid, mercury)
- e. Paints, solvents, and other hazardous fluids
- f. Asbestos based materials
- g. Materials with lead based finishes

Set aside and protect surplus and uncontaminated waste materials. Deliver to or arrange collection by individuals or organizations for verifiable reuse or remanufacturing.

a. Maintain an inventory of removed materials, and submit tracking forms for removed materials indicating type, quantities, condition, destination and end use.

Separate and recycle off-cuts and waste materials in compliance with Waste Management Plan to maximum extent economically feasible

a. Place materials defined as hazardous or toxic waste in designated containers.

g. Return solvent and oil soaked rags for contaminant recovery and laundering or for proper disposal.

**Concrete Forming and Accessories**

**S.3 03 1000**

Separate wood waste in compliance with Waste Management Plan and place in designated areas in following categories for recycling

- a. Solid wood/softwood/hardwood
- b. Composite wood (for example, plywood, OSB, I-joist, parallel strand, MDF, particleboard)
- c. Treated, painted, or contaminated wood

Separate and recycle waste steel formwork accessories in compliance with Waste Management Plan

**S.4 03 2000 Concrete Reinforcing**

Separate and recycle waste reinforcing steel materials in compliance with Waste Management Plan

**S.5 03 3000 CIP Concrete**

Before concrete pours, designate locations or uses for excess concrete. Options include additional paving, post footing anchorage, swale rip-rap reinforcing, mud slab, flowable fill, footing bottom, retaining wall footing ballast, storm structure covers, underground utility pipe kickers, storm pipe flared end section, toe wash protection, and shoulder and toe out-fall restraints for temporary erosion pipes.

Before concrete pours, designate a location for cleaning out concrete trucks. Options include:

- a. Company owned site for that purpose (meeting environmental standards)
- b. Remote on-site area to be paved later in project

Carefully coordinate specified concrete work with weather conditions

Check concrete within 24 hours of placement for flatness, levelness, and other specified tolerances. Adjust formwork and placement techniques on subsequent pours to achieve specified tolerances.

Separate and recycle waste materials in compliance with Waste Management Plan

a. Place materials defined as hazardous or toxic waste in designated containers.

b. Use trigger operated spray nozzles for water hoses



**Arranged by Waste Management Requirements**

Demolition shall be performed in a manner that maximizes salvage and recycling of materials and includes dismantling and removal of materials. Materials dismantled and removed shall be separated, set aside, prepared for reuse, and stored or delivered to collection point for reuse to maximum extent economically feasible.

**WS.1**

S.2	02 4119	Selective Demolition
-----	---------	----------------------

Items listed below have unique or regulated disposal requirements and are to be removed and disposed of in manner dictated by law or in most environmentally responsible manner. Typical concerns are listed in parentheses:

**WS.2**

S.2	02 4119	Selective Demolition
-----	---------	----------------------

a. Fluorescent light ballast manufactured prior to 1978 (PCB)

**WS.3**

S.2	02 4119	Selective Demolition
-----	---------	----------------------

b. Fluorescent lamps (mercury)

**WS.4**

S.2	02 4119	Selective Demolition
-----	---------	----------------------

c. Refrigeration, air-conditioning, and other equipment containing refrigerants (CFC recovery)

**WS.5**

S.2	02 4119	Selective Demolition
-----	---------	----------------------

d. Batteries (Lead, acid, mercury)

**WS.6**

S.2	02 4119	Selective Demolition
-----	---------	----------------------

e. Paints, solvents, and other hazardous fluids

**WS.7**

S.2	02 4119	Selective Demolition
-----	---------	----------------------

f. Asbestos based materials

**WS.8**

S.2	02 4119	Selective Demolition
-----	---------	----------------------

g. Materials with lead based finishes

**WS.9**

S.2	02 4119	Selective Demolition
-----	---------	----------------------

Before concrete pours, designate locations or uses for excess concrete. Options include additional paving, post footing anchorage, swale rip-rap reinforcing, mud slab, flowable fill, footing bottom, retaining wall footing ballast, storm structure covers, underground utility pipe kickers, storm pipe flared end section, toe wash protection, and shoulder and toe out-fall restraints for temporary erosion pipes.

**WS.10**

S.5	03 3000	CIP Concrete
-----	---------	--------------

Before concrete pours, designate a location for cleaning out concrete trucks. Options include:

**WS.11**

S.5	03 3000	CIP Concrete
-----	---------	--------------

a. Company owned site for that purpose (meeting environmental standards)

**WS.12**

S.5	03 3000	CIP Concrete
-----	---------	--------------

b. Remote on-site area to be paved later in project

**WS.13**

S.5	03 3000	CIP Concrete
-----	---------	--------------

Carefully coordinate specified concrete work with weather conditions

**WS.14**

S.5	03 3000	CIP Concrete
-----	---------	--------------

Check concrete within 24 hours of placement for flatness, levelness, and other specified tolerances. Adjust formwork and placement techniques on subsequent pours to achieve specified tolerances.

**WS.15**

S.5	03 3000	CIP Concrete
-----	---------	--------------

Sequence work to minimize use of temporary HVAC to dry out building and control humidity

**WS.16**

S.17	06 1053	Misc. Rough Carpentry
------	---------	-----------------------

**\*\*\*Full versions can be found on the CD.\*\*\***





## Appendix F

### Opinion Survey Response



### SECTION 1

What kind of company do you work for?

- 1\_Owner
- 2\_Architect
- 1\_Construction Manager
- General Contractor
- 8\_Trade Contractor
- Supplier
- 1\_Manufacturer
- 3\_Other: **MEP Engineer, Demolition, Civil Engineer**

Have you participated in the design or construction of a LEED certified building?

- 9\_Yes. Please proceed to SECTION 2
- 6\_No. Please proceed to SECTION 3

### SECTION 2

How many LEED certified building did you take part in?

- 1building/project 3 companies**
- 2 buildings/projects 4 companies**
- 6 buildings/ projects 1 companies**
- 24 building/projects 1 company**

What were the ratings?

- 15\_Certified
- 16\_Silver
- 10\_Gold
- Platinum

If you are a trade partner, supplier or manufacturer, did you have any problems implementing the needed requirements for the anticipated LEED points: MR 2 (Construction Waste Management), MR 4(Recycled Content), MR 5(Local/Regional Materials)?

- 1\_Yes
- 3\_No

If yes, please provide explanation.

- **Most window blind manufacturers comply with LEEDs, Springs Window Fashions (Bali Blinds) utilizes 42% recycles aluminum and 20% recycled steel in their products.**



Construction Management | Dr. Riley | Germantown, Maryland | April 9, 2008

- In some instances, finding components that met recycled content was difficult. However we were able to meet the requirements and also provide the necessary low VOC adhesives

Was there any trouble obtaining verification information needed for submittals?

4 Yes

3 No

If yes, please provide explanation.

- The electrical industry is a little behind the curve in regard to LEED requirements.
- Each project seem to have a different reporting process or it was left up to us to come up with a spread sheet that conveyed the information needed for accounting or recycled materials for the project. We are a demolition contractor and the salvage of materials is critical to this process. Also getting the documentation from scrap yards or salvage yards sometimes can be complicated.
- Since Milestone Business Park was a phased site, and part of the stormwater management for the site was being handled off-site in an already-constructed regional (State Highway) stormwater management pond, it was difficult to find the necessary data on that regional pond to address the LEED point for stormwater management quantity control.

When fulfilling requirements for MR 2 Construction Waste Management, what method was used?

3 third party to separate co-mingled trash

3 separate recycling bins on site for different materials

Why did you choose this method?

- Packing materials were placed in G.C. provided containers in some instances recycle containers have been provided for cardboard. Blind debris was taken to a recycling facility.
- Each building used each method. From what I have heard, it is easier to let 3<sup>rd</sup> party sort. This would especially be true of mid or hi rise building that are constructed with trash chutes as you could end up having to install separate trash chutes.
- Determined by GC.
- This is customary for our operation (demo).

Where there any complications?

- No, complications have ever occurred.
- We haven't broken ground yet...so unknown.



Did you have any trouble finding products with the noted recycled content in MR4 Recycled Content?

3 Yes

2 No

If yes, please provide explanation.

- As mentioned before
- Electrical industry is behind the curve and lots of our materials etc are manufactured overseas.
- We are currently tracking under our goal of 20%

Were there any trouble finding local materials, suppliers and/or manufacturers for MR 5 Local Materials?

3 Yes

2 No

If yes, please provide explanation.

- Many of our materials are not manufactured within the 500 miles.
- We are currently tracking 10%. We are not certain we can meet the 20%.
- The architect didn't choose products that are consider local.
- Some products were custom made, which made them come from a different place.

### SECTION 3

Would your company be interested in pursuing a LEED project?

13 Yes

1 No

If yes, are you looking to start a LEED project?

- As a window treatment contractor we always try to help with LEED ratings.
- We accept and start LEED projects as they come along. With regards to how we pursue a job, we pursue jobs with equal tenacity regardless if they are LEED or not.
- We are pursuing the LEED points on an interior project, without any submission or certification.
- No. We are a subcontractor, not a LEED trade or LEED Design company.
- Not currently in the DC office, but multiple underway at other offices.
- We have already participated in LEED projects.
- None started at this time.



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- Some of our bid projects have LEED/Green requirements. I would bid them but I do not know enough of the requirements to start one.
- In today's market you have to be interested in pursuing LEED projects because it is the way of the future.
- Yes – all most all of our developments moving forward will be LEED.
- We are currently under contract to begin a LEED project, but we have not started yet.

If no, please provide explanation.

- We operate a small business with minimum office overhead. To take more office work would require us to hire another employee.

Do you feel that you have adequate knowledge of the LEED design and construction?

     Yes

  13   No

Please provide explanation.

- Never done it before.
- We have sufficient knowledge to complete the projects. However more LEED certified classes in this area would be helpful. If there are many already, we do not know about them.
- I am currently studying for the LEED test, but have just started.
- We have the knowledge but our experience is that the documentation portion for the MEP is not standardized enough. We appear to be “inventing the wheel” each time for the documentation.
- We are learning as we go...
- We have LEED certified staff in our office and firm but I am not personally certified.
- The guidelines are not specific to materials (brands, etc) and method used in achieving certain objectives.
- I know of the materials manufacturing requirements within a certain radius of the project and special requirements for the glazing in the building shell.
- I think the process needs to be more standardized and there needs to be more training in the industry. We have a good understanding from a demolition contractor's view but not for the entire project.
- But I am learning more daily.
- There is no central source to find LEED information. Everything seems to be on a job-by-job basis.



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What factors do you feel that have preventing your company from taking part in a LEED project?

- I think the biggest setback to LEED projects is the initial cost impact of products required for LEED certification, most often the long term savings and long term environmental savings are often overlooked due to initial cost(s).
- Nothing has prevented us from taking part in any LEED project
- Lack of opportunity
- The documentation for the MEP portion. The completion of the actual credit templates has not been a problem.
- Cost impacts are new to most of us and may not be properly covered in a competitively bid project. If the low bidders drive the cost down, the rest of the industry has to lower their cost as well until everyone gets hurt financially quite a few times and then captures the additional cost impact in the bids.
- We have - I have not.
- We did not get awarded the bid projects with LEED requirements.
- We really have not shied away from LEED projects. Although they are more of a hassle because of all the paper work involved.
- Red tape.

#### SECTION 4

Was the LEED implementation process successful?

8 Yes

No

Please provide explanation.

- I think there is still a lot of ground work to be done here and the increased costs required to comply with LEEDs needs to be better understood by all.
- Seems to have been successful but we were only a very small part of the process.
- Nobody has complained.
- Yes, in the demolition of a project a lot of points can be rendered because of the sheer volume of materials that get recycled.
- From my perspective, the LEED consultant guided us through the process effectively

For trade contractors, was this your first LEED project?

1 Yes

4 No



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If yes, did you find that when implementing the LEED process for the first time, that you had trouble with any of the requirements?

- Not really but the 1<sup>st</sup> one was only certified and we are working in the design build phase of the 2<sup>nd</sup> one.
- The water based adhesives are formaldehyde free products are inferior.
- It is difficult to meet all of the recycled contents, debris sorting. Meeting the wood requirements is difficult and expensive.

Do you feel that a LEED guide made for trade contractors would be beneficial when implementing LEED into a construction project?

  9   Yes!

     No

- The more information that is out there the better.
- It needs to be specific.

Do you have any suggestions for what can make this process smoother?

- A brief overview of the process, a flow chart of how to proceed, including when to use the documents.
- As I opened each document, I did not grasp all the information, but then reading subsequent documents, I could understand the earlier documents better, but I had to work at it.
- Providing a list of sources for common LEED materials and publications that can educate the contractors.
- You just nailed it. Step one, step 2...would be great
- For the trades, an updatable website showing current means and methods, brand names or products meeting specific criteria, might be more helpful.
- Have a guide for each specific trade versus a general guide. Most subs would want a guideline outlined what they would need to do as opposed to making interpretations of what could be done.
- A software package designed for the accounting aspect of the process. Also some things like GWB are hard to recycle because there are not enough facilities to handle the quantities that are generated. In some cases the cost to recycle far exceeds the benefit to recycle the materials.



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As a trade contractor, do you have your own thoughts about recycling materials that is not mentioned in the LEED guidelines?

- Not really, other than I agree with recycling materials whenever one can.
- Sort by 3<sup>rd</sup> party is the way to go.
- Many of the manufacturers are recycling materials already. Manufacturing locally and wood products is the most difficult.
- For glass and glazing the aluminum portion is not hard to recycle but the glass is. If there was a service for picking up the broken/scrap glass and taking it to a manufacturer/recycler would be good. Right now there is no economical way to achieve this. All glass companies have this waste to deal with.

What benefits have you seen in the LEED projects? Are you happy with your decision in taking part of a LEED project?

- I am always happy to take part in a project, especially one that has less of an impact on the environment; unfortunately, I think far too often costs associated prohibit many of the facets of LEEDs implementation.
- We have not seen any direct benefits, although I do not argue that they exist.
- As an Architect, I am involved in a project that requires waste recycling and other green requirements, but it is not intended to be LEED certified. I am happy to be a part of this process.
- We see benefits to the tenants for the Commercial Interiors portion in that the actual installation of the engineer's design is field verified during the commissioning process and eliminates problems with the installation.
- Yes.
- We participate in LEED because it is the future – and we all need a pay check. Currently, the LEED products are inferior and we can foresee a time when these current (first users of LEED) will be unhappy with the length or longevity of the end product in their spaces.
- As a subcontractor – no benefits. It cost more in management and not able to add cost to the project.
- The obvious benefit is that we are reusing resources. We are happy to participate in LEED projects. In most cases it is cost effective to recycle in our business because it saves money or generates money in the case of salvage cost for metals and other similar materials.
- Awareness of the environmental impacts of construction is a definite benefit. I am quite happy to have taken part.





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- I believe that it is our responsibility to continue to better our environment. The numbers are staggering on how inefficient current buildings operate and how construction is managed. I believe that with these little steps we can make huge differences.

Please feel free to add any additional comments.

- LEED requirements add cost to the project but for most part is a feel good thing. The real brakes come from the government on tax savings. The energy savings on insulating, heating, cooling and any energy consuming devices could be specified and designed without the LEED requirements and be achieved less costly.
- Most people, myself included, are unfamiliar with LEED/Green requirements. These kinds of issues have major impacts, repercussions and consequences that need to be dealt with today for future generations.



**Appendix G**  
**LEED Survey Response**



## LEED Guidelines for Trade Contractors

Once you review the guide, please answer the following questions.

Was this guide easy to understand?

5 Yes

No

Please provide explanation.

- It's nice to see each specific specification section/trade outlined.
- Basically for trade contractors a menu based system for LEED accounting would be better. A system where we could click on Demolition requirements and everything that pertains to LEED for demolition is supplied. Also a system where we can just fill in the blanks on a daily basis would be helpful.

Was it user friendly?

5 Yes

No

Please provide explanation.

Do you find it helpful?

5 Yes

No

Please provide explanation.

- Not so much for our specific trade (electrical) but as I'm sure you are aware, most of the LEED requirements revolve around other construction disciplines and the design teams efforts.
- Architectural Specification say to use "formaldehyde free substrate" or "water based adhesives" So far, we have not had to do any of the calculations or research into other ways to help the specifications. So, we do not yet have a need to research any further.
- Yes I think you are on the right track. The recording of the information is the most time sensitive issue and that is where I think the system needs to make this process easy for the contractor to complete.
- I think that the pamphlet was done well.
- I think that you are on the right track to try and standardize this package. It is very much needed in the industry. If I may borrow a thing in the tax world that many



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have adopted to do their taxes is “Turbo Tax”. We need a “Turbo LEED” program that is easy to use and applicable to the certification process. I hope you get high marks for you efforts in this most important aspect of the construction industry.

Do you have any suggestions in how I can improve this guide?

- For Div 16 Electrical, My suggestion would be to follow the way standard electrical specs are laid out and to put the LEED requirements specific to that section in that spec section. Example: Bus Duct: then go on to list the requirements for that specific product. It would also be very helpful to separate manufacturer requirements from installing contractor requirements when putting this together. That way, we can make sure that the vendor quoting that particular product knows exactly what is expected of them etc.
- Most of the requirements were in general type processes. If each trade had a specific XYZ type of guideline it would be less in the hands of Interpretation of the individual and more concrete. With business being what it is it would be more efficient and productive to have a guideline that basically said what was Right or Wrong. When you get into gray areas that are when good intentions may lead you to the wrong choice, even though the individual thinks what they are doing is the right thing to do.

Example:

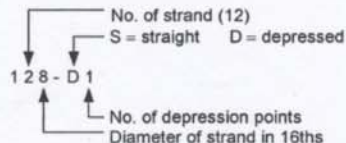
Clear glass if recycled could be reused as cullet in making new glass at the float plant stage (ie: where they melt sand down to make raw glass). Some clear glass has coatings on it that are not visible to the naked eye and if this type of glass is mixed with the raw sand the new product will have imperfections in it resulting in more new glass needing to be manufactured. Good intentions, in this case, impact raw materials required, whatever the nature resource was required to process the materials, time, labor and profit because more of all were required.

The use of more raw materials, use of more of the natural resource required to process it and additional waste management required to dispose of the imperfections all have affected the environment, but the intentions were good. That is why guidelines with simplified Right or Wrong criteria would be more beneficial.



**Appendix H**  
**PCI Design Charts**

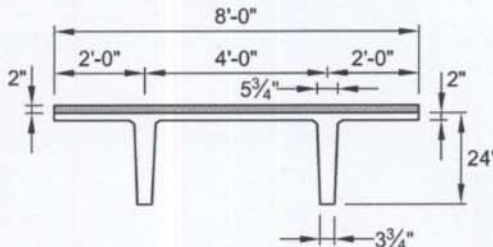
**Strand Pattern Designation**



Safe loads shown include dead load of 10 psf for untopped members and 15 psf for topped members. Remainder is live load. Long-time cambers include superimposed dead load but do not include live load.

**Key**  
 196 - Safe superimposed service load, psf  
 1.2 - Estimated camber at erection, in.  
 1.5 - Estimated long-time camber, in.

**DOUBLE TEE**  
**8'-0" x 24"**  
**Lightweight Concrete**



$f'_c = 5,000$  psi  
 $f_{pu} = 270,000$  psi

**Section Properties**  
 Untopped      Topped

A =	401 in. <sup>2</sup>	-
I =	20,985 in. <sup>4</sup>	29,857 in. <sup>4</sup>
y <sub>b</sub> =	17.15 in.	19.94 in.
y <sub>t</sub> =	6.85 in.	6.06 in.
S <sub>b</sub> =	1,224 in. <sup>3</sup>	1,497 in. <sup>3</sup>
S <sub>t</sub> =	3,064 in. <sup>3</sup>	4,927 in. <sup>3</sup>
wt =	418 plf	520 plf
DL =	40 psf	65 psf
V/S =	1.41 in.	

**8LDT24**

**Table of safe superimposed service load (psf) and cambers (in.)**

**No Topping**

Strand Pattern	y <sub>s</sub> (end) in. y <sub>s</sub> (center) in.	Span, ft																											
		32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80			
68-S	4.00	196	170	149	131	115	102	90	80	72	64	57	51	45	40	36	32	28											
	4.00	1.2	1.3	1.4	1.5	1.6	1.6	1.7	1.8	1.8	1.9	1.9	1.9	1.9	1.8	1.7	1.6	1.4											
88-S	5.00		194	171	152	135	121	108	97	87	79	71	64	58	52	47	43	38	35	31	28								
	5.00		1.8	1.9	2.1	2.2	2.3	2.5	2.6	2.7	2.7	2.8	2.8	2.9	2.9	2.8	2.8	2.6	2.5	2.3	2.0								
108-S	6.00			183	164	147	132	119	107	97	87	78	70	64	58	53	48	44	40	36	33	29	26						
	6.00			2.4	2.5	2.7	2.9	3.0	3.2	3.3	3.4	3.5	3.6	3.6	3.7	3.7	3.6	3.5	3.3	3.1	2.9	2.5	2.0	1.5	0.8	0.0			
128-S	7.00									110	99	89	80	72	65	59	53	49	44	40	37	34	31	28					
	7.00									3.7	3.8	3.9	4.0	4.1	4.2	4.2	4.2	4.1	4.0	3.9	3.7	3.5	3.2						
128-D1	11.67																83	76	69	62	57	51	46	42	38	34			
	3.25																4.8	4.9	5.0	5.1	5.1	5.0	4.9	4.6	4.3				
148-D1	12.86																												
	3.50																												

**8LDT24 + 2**

**Table of safe superimposed service load (psf) and cambers (in.)**

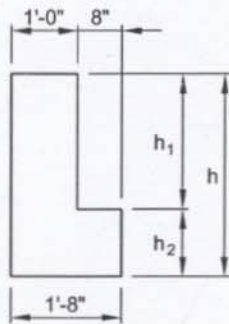
**2 in. Normal Weight Topping**

Strand Pattern	y <sub>s</sub> (end) in. y <sub>s</sub> (center) in.	Span, ft																										
		28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74			
48-S	3.00	178	150	126	107	90	76	64	54	45	38	31	25															
	3.00	0.6	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0	1.0	1.0	0.9															
68-S	4.00		198	170	147	127	111	96	84	73	63	55	47	40	34	29												
	4.00		1.2	1.3	1.4	1.5	1.6	1.7	1.7	1.8	1.9	1.9	1.9	1.9	1.9	1.8												
88-S	5.00			197	172	151	133	117	103	91	80	71	61	52	45	37	31	25										
	5.00			1.8	1.9	2.1	2.2	2.3	2.5	2.6	2.7	2.7	2.8	2.8	2.9	2.9	2.8	2.8										
108-S	6.00					186	164	146	129	115	102	89	76	65	56	48	41	34	29									
	6.00					2.4	2.5	2.7	2.9	3.0	3.2	3.3	3.4	3.5	3.6	3.6	3.7	3.7	3.7									
128-S	7.00																											
	7.00																											
128-D1	11.67																											
	3.25																											

Strength is based on strain compatibility; bottom tension is limited to  $12\sqrt{f'_c}$ ; see pages 2-7 through 2-10 for explanation. Shaded values require release strengths higher than 3500 psi.

## L-BEAMS

Normal Weight Concrete



$f'_c = 5,000$  psi  
 $f_{pu} = 270,000$  psi  
 1/2 in. diameter  
 low-relaxation strand

Designation	h in.	h <sub>1</sub> /h <sub>2</sub> in./in.	A in. <sup>2</sup>	I in. <sup>4</sup>	y <sub>b</sub> in.	S <sub>b</sub> in. <sup>3</sup>	S <sub>t</sub> in. <sup>3</sup>	wt plf
20LB20	20	12/8	304	10,160	8.74	1,163	902	317
20LB24	24	12/12	384	17,568	10.50	1,673	1,301	400
20LB28	28	16/12	432	27,883	12.22	2,282	1,767	450
20LB32	32	20/12	480	41,600	14.00	2,971	2,311	500
20LB36	36	24/12	528	59,119	15.82	3,737	2,930	550
20LB40	40	24/16	608	81,282	17.47	4,653	3,608	633
20LB44	44	28/16	656	108,107	19.27	5,610	4,372	683
20LB48	48	32/16	704	140,133	21.09	6,645	5,208	733
20LB52	52	36/16	752	177,752	22.94	7,749	6,117	783
20LB56	56	40/16	800	221,355	24.80	8,926	7,095	833
20LB60	60	44/16	848	271,332	26.68	10,170	8,143	883

1. Check local area for availability of other sizes.
2. Safe loads shown include 50% superimposed dead load and 50% live load. 800 psi top tension has been allowed, therefore, additional top reinforcement is required.
3. Safe loads can be significantly increased by use of structural composite topping.

### Key

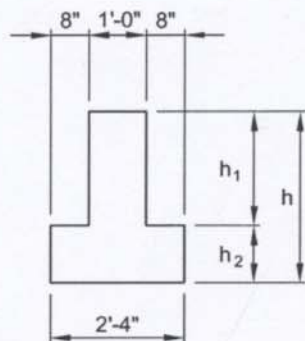
- 6566 – Safe superimposed service load, plf.
- 0.3 – Estimated camber at erection, in.
- 0.1 – Estimated long-time camber, in.

**Table of safe superimposed service load (plf) and cambers (in.)**

Designation	No. Strand	y <sub>s</sub> (end) in. y <sub>s</sub> (center) in.	Span, ft																			
			16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50		
20LB20	98-S	2.44 2.44	6566	5131	4105	3345	2768	2318	1961	1674	1438	1243	1079									
			0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.1	1.2									
			0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.2									
20LB24	108-S	2.80 2.80	9577	7495	6006	4904	4066	3414	2896	2479	2137	1854	1617	1416	1244	1097	969					
			0.3	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.2					
			0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.0	0.0				
20LB28	128-S	3.33 3.33	8228	6733	5596	4711	4009	3443	2979	2595	2273	2000	1768	1567	1394	1243	1110	992				
			0.4	0.4	0.5	0.6	0.6	0.7	0.8	0.9	0.9	1.0	1.1	1.1	1.2	1.2	1.2	1.3				
			0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.0	0.0		
20LB32	148-S	3.71 3.71	8942	7446	6281	5356	4611	4001	3495	3071	2712	2406	2143	1914	1715	1540	1386					
			0.4	0.5	0.5	0.6	0.7	0.7	0.8	0.9	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.3				
			0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.0	0.0	
20LB36	168-S	4.25 4.25	9457	7988	6823	5883	5113	4476	3941	3489	3103	2771	2483	2231	2011	1816						
			0.4	0.5	0.5	0.6	0.7	0.8	0.8	0.9	1.0	1.1	1.1	1.2	1.2	1.3	1.3					
			0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	
20LB40	188-S	4.89 4.89	9812	8386	7235	6293	5513	4858	4305	3832	3425	3073	2765	2495	2257							
			0.4	0.5	0.6	0.6	0.7	0.8	0.8	0.9	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.3				
			0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
20LB44	198-S	5.05 5.05	8959	7803	6845	6042	5363	4783	4284	3851	3474	3143	2850									
			0.5	0.6	0.6	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.3				
			0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
20LB48	218-S	5.81 5.81	9226	8100	7158	6360	5678	5092	4584	4140	3751	3408										
			0.5	0.6	0.6	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.3				
			0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
20LB52	238-S	6.17 6.17	9634	8521	7578	6774	6082	5482	4958	4499	4094											
			0.6	0.6	0.7	0.7	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.3	1.3				
			0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
20LB56	258-S	6.64 6.64	9954	8860	7927	7124	6427	5820	5287	4816												
			0.6	0.7	0.7	0.8	0.8	0.9	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.3	1.3	1.3				
			0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
20LB60	278-S	7.33 7.33	9089	8173	7380	6688	6080	5544														
			0.7	0.7	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.3	1.3	1.3	1.3				
			0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3

# INVERTED TEE BEAMS

Normal Weight Concrete



$f'_c = 5,000$  psi  
 $f_{pu} = 270,000$  psi  
 $\frac{1}{2}$  in. diameter  
 low-relaxation strand

Section Properties								
Designation	h in.	$h_1/h_2$ in./in.	A in. <sup>2</sup>	I in. <sup>4</sup>	$y_b$ in.	$S_b$ in. <sup>3</sup>	$S_t$ in. <sup>3</sup>	wt plf
28IT20	20	12/8	368	11,688	7.91	1,478	967	383
28IT24	24	12/12	480	20,275	9.60	2,112	1,408	500
28IT28	28	16/12	528	32,076	11.09	2,892	1,897	550
28IT32	32	20/12	576	47,872	12.67	3,778	2,477	600
28IT36	36	24/12	624	68,101	14.31	4,759	3,140	650
28IT40	40	24/16	736	93,503	15.83	5,907	3,869	767
28IT44	44	28/16	784	124,437	17.43	7,139	4,683	817
28IT48	48	32/16	832	161,424	19.08	8,460	5,582	867
28IT52	52	36/16	880	204,884	20.76	9,869	6,558	917
28IT56	56	40/16	928	255,229	22.48	11,354	7,614	967
28IT60	60	44/16	976	312,866	24.23	12,912	8,747	1,017

1. Check local area for availability of other sizes.
2. Safe loads shown include 50% superimposed dead load and 50% live load. 800 psi top tension has been allowed, therefore, additional top reinforcement is required.
3. Safe loads can be significantly increased by use of structural composite topping.

### Key

- 6511 – Safe superimposed service load, plf.
- 0.2 – Estimated camber at erection, in.
- 0.1 – Estimated long-time camber, in.

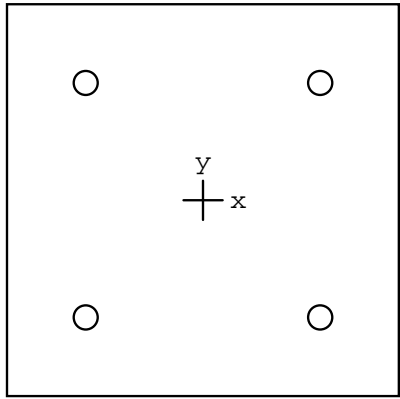
Table of safe superimposed service load (plf) and cambers (in.)

Designation	No. Strand	$y_s(\text{end})$ in. $y_s(\text{center})$ in.	Span, ft																																							
			16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50																						
28IT20	98-S	2.44 2.44	6511	5076	4049	3289	2711	2262	1905	1617	1381	1186	1022	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.7	0.8	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	-0.1									
28IT24	188-S	2.73 2.73	9612	7504	5997	4882	4034	3374	2850	2427	2081	1795	1555	1351	1178	1029	0.2	0.3	0.3	0.4	0.4	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.1	0.1	0.1	0.1	0.1	0.0	0.0	-0.1	-0.2	
28IT28	138-S	3.08 3.08	8353	6822	5657	4750	4031	3451	2976	2582	2252	1973	1735	1530	1352	1197	1061	0.3	0.3	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.9	0.8	0.8	0.1	0.1	0.1	0.1	0.1	0.0	0.0	-0.1	-0.2	-0.2
28IT32	158-S	3.47 3.47	9049	7521	5333	5389	4628	4006	3490	3057	2691	2379	2110	1876	1673	1495	1337	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	-0.1
28IT36	168-S	3.50 3.50	9832	8295	7075	6092	5287	4619	4060	3587	3183	2835	2534	2271	2040	1836	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	-0.1
28IT40	198-S	4.21 4.21	8638	7440	6460	5647	4966	4390	3898	3474	3107	2787	2506	2258	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		
28IT44	208-S	4.40 4.40	9186	7989	6997	6165	5462	4861	4344	3896	3505	3162	2859	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0			
28IT48	228-S	4.55 4.55	9719	8525	7523	6676	5953	5330	4791	4320	3907	3542	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1				
28IT52	248-S	5.17 5.17	9987	8823	7838	6998	6274	5647	4100	4619	4196	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1				
28IT56	268-S	5.23 5.23	9307	8319	7469	6731	6088	5524	5026	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2				
28IT60	288-S	5.57 5.57	9645	8668	7820	7081	6432	5859	0.6	0.6	0.7	0.7	0.8	0.8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2				





**Appendix I**  
**PCA Column Calculations**



14 x 14 in

Code: ACI 318-02

Units: English

Run axis: About X-axis

Run option: Investigation

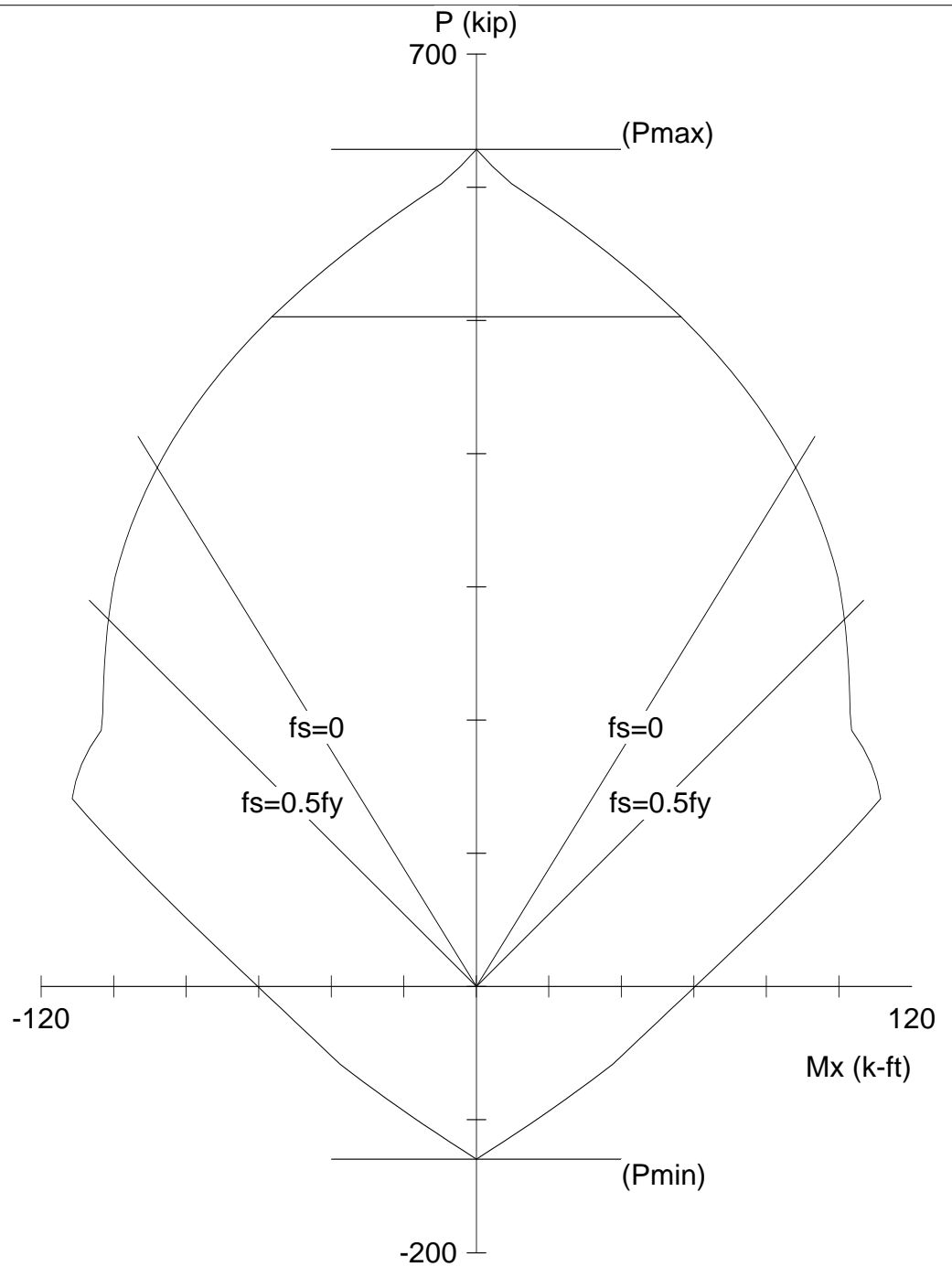
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 04/04/08

Time: 21:41:23



pcaColumn v3.64. Licensed to: Penn State University. License ID: 52411-1010265-4-22545-28F4D

File: untitled.col

Project:

Column:

$f'_c = 5$  ksi

$E_c = 4031$  ksi

$f_c = 4.25$  ksi

$e_u = 0.003$  in/in

Beta1 = 0.8

Confinement: Tied

$f_y = 60$  ksi

$E_s = 29000$  ksi

$f_c = 4.25$  ksi

$\phi(a) = 0.8, \phi(b) = 0.9, \phi(c) = 0.65$

Engineer:

$A_g = 196$  in<sup>2</sup>

$A_s = 2.40$  in<sup>2</sup>

$X_o = 0.00$  in

$Y_o = 0.00$  in

Clear spacing = 7.50 in

4 #7 bars

Rho = 1.22%

$I_x = 3201.33$  in<sup>4</sup>

$I_y = 3201.33$  in<sup>4</sup>

Clear cover = 2.38 in

General Information:

=====

File Name: untitled.col  
 Project:  
 Column: Engineer:  
 Code: ACI 318-02 Units: English  
 Run Option: Investigation Slenderness: Not considered  
 Run Axis: X-axis Column Type: Structural

Material Properties:

=====

f'c = 5 ksi fy = 60 ksi  
 Ec = 4030.51 ksi Es = 29000 ksi  
 Ultimate strain = 0.003 in/in  
 Beta1 = 0.8

Section:

=====

Rectangular: Width = 14 in Depth = 14 in  
 Gross section area, Ag = 196 in^2  
 Ix = 3201.33 in^4 Iy = 3201.33 in^4  
 Xo = 0 in Yo = 0 in

Reinforcement:

=====

Rebar Database: ASTM A615

Size	Diam (in)	Area (in^2)	Size	Diam (in)	Area (in^2)	Size	Diam (in)	Area (in^2)
# 3	0.38	0.11	# 4	0.50	0.20	# 5	0.63	0.31
# 6	0.75	0.44	# 7	0.88	0.60	# 8	1.00	0.79
# 9	1.13	1.00	# 10	1.27	1.27	# 11	1.41	1.56
# 14	1.69	2.25	# 18	2.26	4.00			

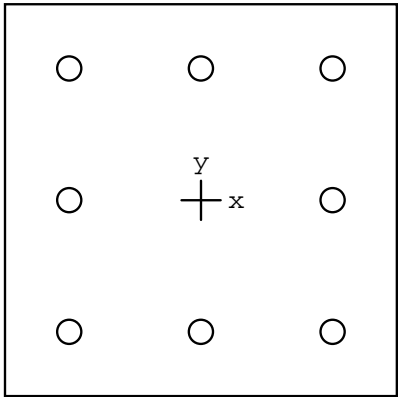
Confinement: Tied; #3 ties with #10 bars, #4 with larger bars.  
 phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

Layout: Rectangular  
 Pattern: All Sides Equal (Cover to transverse reinforcement)  
 Total steel area, As = 2.40 in^2 at 1.22%  
 4 #7 Cover = 2 in

Control Points:

=====

Bending about	Axial Load P kip	X-Moment k-ft	Y-Moment k-ft	N.A. depth in
X @ Pure compression	628.4	-0	-0	36.05
@ Max compression	502.7	56	0	14.45
@ fs = 0.0	389.6	88	0	11.19
@ fs = 0.5*fy	275.6	101	0	8.32
@ Balanced point	193.8	103	0	6.62
@ Tension Control	141.3	112	-0	4.20
@ Pure bending	-0.0	60	0	2.17
@ Pure tension	-129.6	0	0	0.00
-X @ Pure compression	628.4	-0	-0	36.05
@ Max compression	502.7	-56	-0	14.45
@ fs = 0.0	389.6	-88	0	11.19
@ fs = 0.5*fy	275.6	-101	0	8.32
@ Balanced point	193.8	-103	0	6.62
@ Tension Control	141.3	-112	-0	4.20
@ Pure bending	-0.0	-60	-0	2.17
@ Pure tension	-129.6	0	0	0.00



18 x 18 in

Code: ACI 318-02

Units: English

Run axis: About X-axis

Run option: Investigation

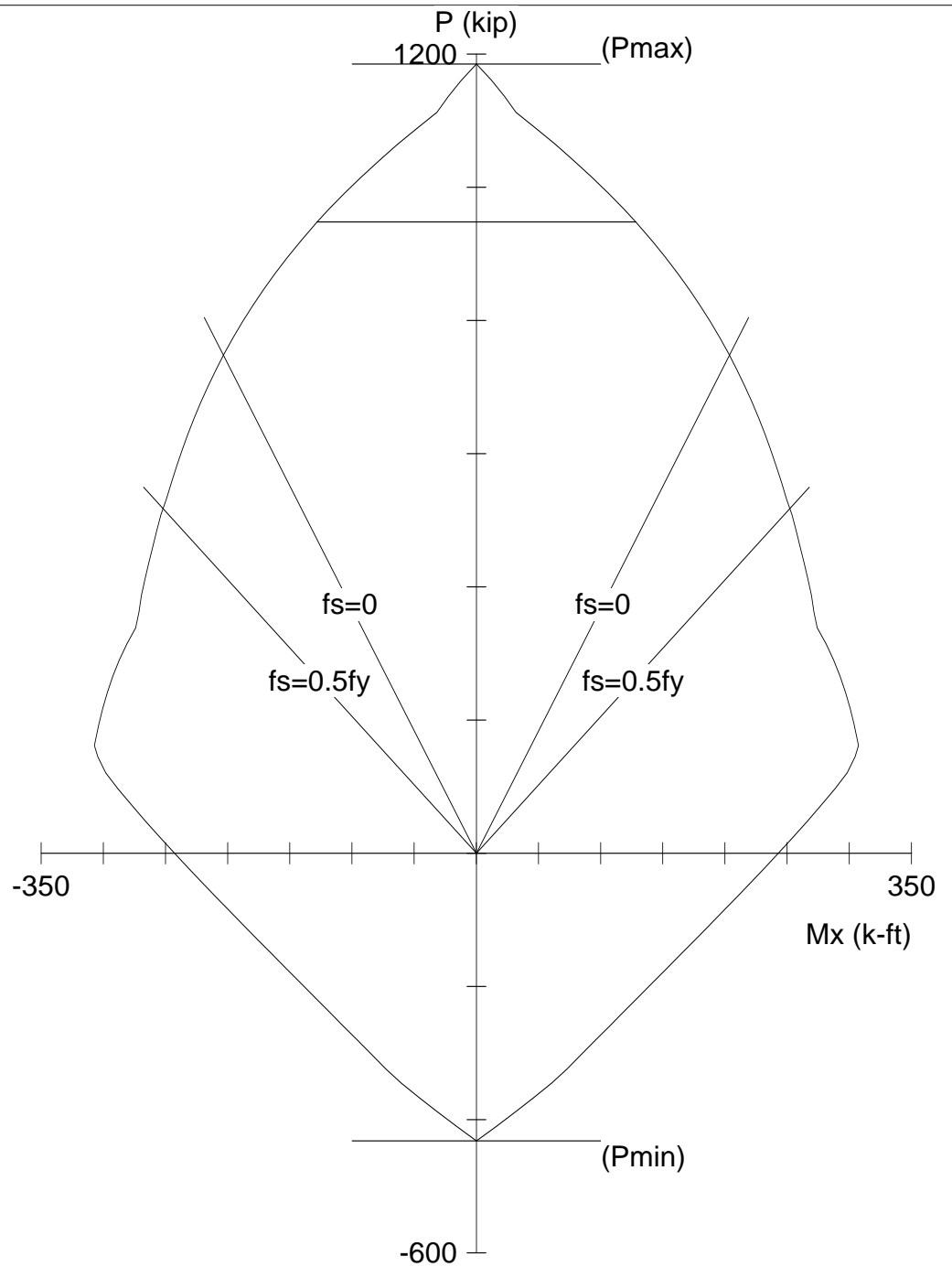
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 04/04/08

Time: 21:42:16



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File: untitled.col

Project:

Column:

$f'_c = 5$  ksi

$E_c = 4031$  ksi

$f_c = 4.25$  ksi

$e_u = 0.003$  in/in

Beta1 = 0.8

Confinement: Tied

$f_y = 60$  ksi

$E_s = 29000$  ksi

$f_c = 4.25$  ksi

$\phi(a) = 0.8, \phi(b) = 0.9, \phi(c) = 0.65$

Engineer:

$A_g = 324$  in<sup>2</sup>

$A_s = 8.00$  in<sup>2</sup>

$X_o = 0.00$  in

$Y_o = 0.00$  in

Clear spacing = 4.93 in

8 #9 bars

Rho = 2.47%

$I_x = 8748$  in<sup>4</sup>

$I_y = 8748$  in<sup>4</sup>

Clear cover = 2.38 in

General Information:

=====

File Name: untitled.col  
 Project:  
 Column: Engineer:  
 Code: ACI 318-02 Units: English  
 Run Option: Investigation Slenderness: Not considered  
 Run Axis: X-axis Column Type: Structural

Material Properties:

=====

f'c = 5 ksi fy = 60 ksi  
 Ec = 4030.51 ksi Es = 29000 ksi  
 Ultimate strain = 0.003 in/in  
 Beta1 = 0.8

Section:

=====

Rectangular: Width = 18 in Depth = 18 in  
 Gross section area, Ag = 324 in<sup>2</sup>  
 Ix = 8748 in<sup>4</sup> Iy = 8748 in<sup>4</sup>  
 Xo = 0 in Yo = 0 in

Reinforcement:

=====

Rebar Database: ASTM A615

Size	Diam (in)	Area (in <sup>2</sup> )	Size	Diam (in)	Area (in <sup>2</sup> )	Size	Diam (in)	Area (in <sup>2</sup> )
# 3	0.38	0.11	# 4	0.50	0.20	# 5	0.63	0.31
# 6	0.75	0.44	# 7	0.88	0.60	# 8	1.00	0.79
# 9	1.13	1.00	# 10	1.27	1.27	# 11	1.41	1.56
# 14	1.69	2.25	# 18	2.26	4.00			

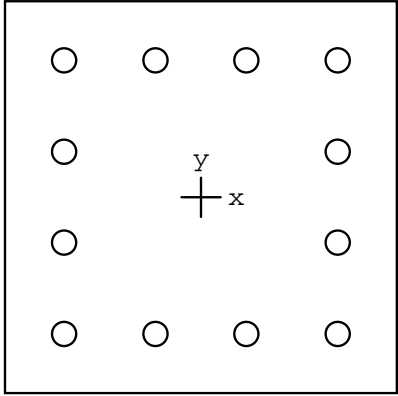
Confinement: Tied; #3 ties with #10 bars, #4 with larger bars.  
 phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

Layout: Rectangular  
 Pattern: All Sides Equal (Cover to transverse reinforcement)  
 Total steel area, As = 8.00 in<sup>2</sup> at 2.47%  
 8 #9 Cover = 2 in

Control Points:

=====

Bending about	Axial Load P kip	X-Moment k-ft	Y-Moment k-ft	N.A. depth in
X @ Pure compression	1184.9	-0	-0	48.53
@ Max compression	948.0	128	0	19.05
@ fs = 0.0	747.8	203	0	15.06
@ fs = 0.5*fy	517.9	252	0	11.20
@ Balanced point	341.9	273	0	8.91
@ Tension Control	157.3	308	0	5.65
@ Pure bending	0.0	243	0	3.99
@ Pure tension	-432.0	0	0	0.00
-X @ Pure compression	1184.9	-0	-0	48.53
@ Max compression	948.0	-128	-0	19.05
@ fs = 0.0	747.8	-203	-0	15.06
@ fs = 0.5*fy	517.9	-252	0	11.20
@ Balanced point	341.9	-273	0	8.91
@ Tension Control	157.3	-308	-0	5.65
@ Pure bending	0.0	-243	-0	3.99
@ Pure tension	-432.0	0	0	0.00



20 x 20 in

Code: ACI 318-02

Units: English

Run axis: About X-axis

Run option: Investigation

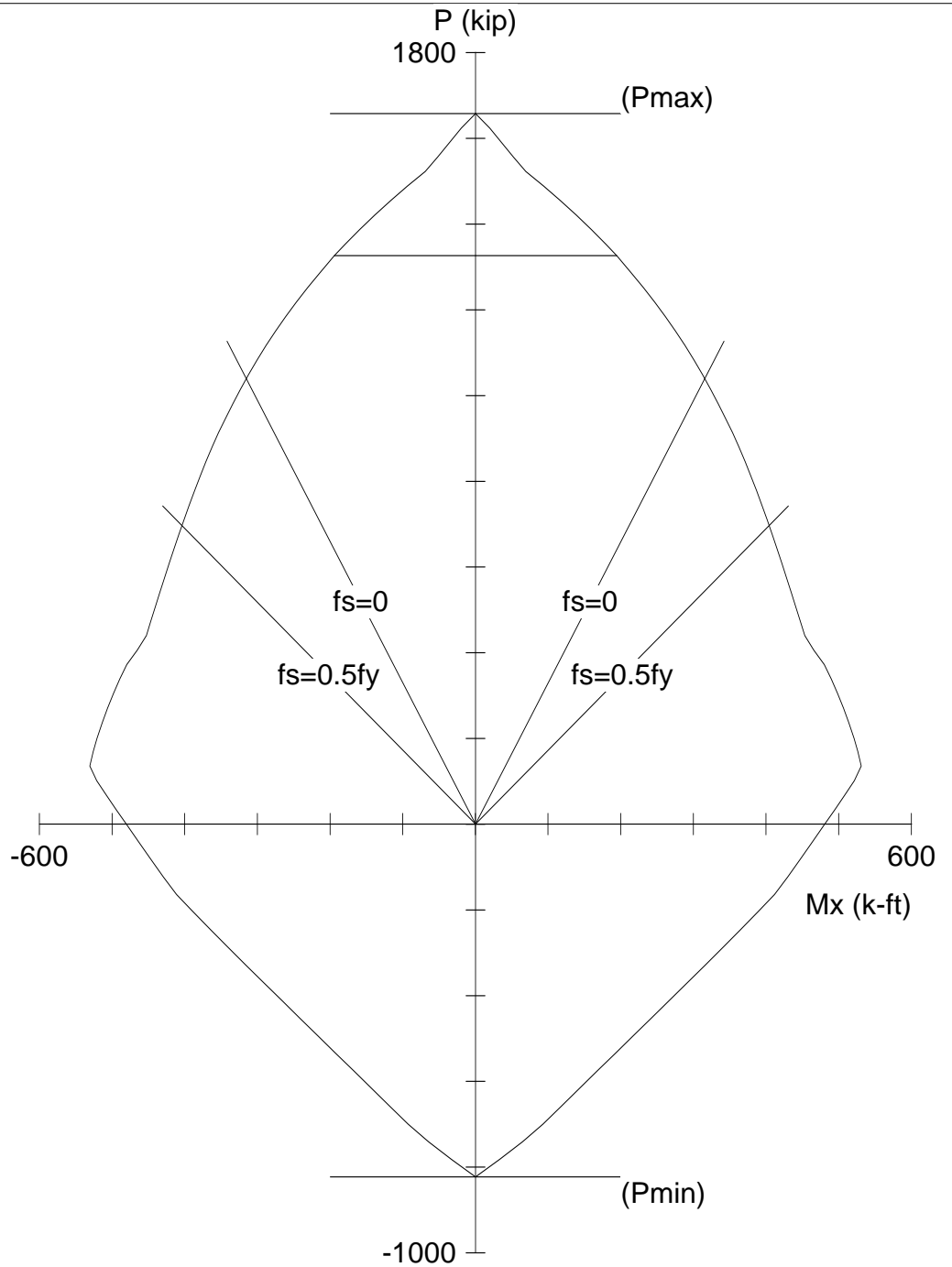
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 04/04/08

Time: 21:43:33



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File: untitled.col

Project:

Column:

$f'_c = 5$  ksi

$E_c = 4031$  ksi

$f_c = 4.25$  ksi

$e_u = 0.003$  in/in

Beta1 = 0.8

Confinement: Tied

$f_y = 60$  ksi

$E_s = 29000$  ksi

$f_c = 4.25$  ksi

$\phi(a) = 0.8, \phi(b) = 0.9, \phi(c) = 0.65$

Engineer:

$A_g = 400$  in<sup>2</sup>

$A_s = 15.24$  in<sup>2</sup>

$X_o = 0.00$  in

$Y_o = 0.00$  in

Clear spacing = 3.39 in

12 #10 bars

Rho = 3.81%

$I_x = 13333.3$  in<sup>4</sup>

$I_y = 13333.3$  in<sup>4</sup>

Clear cover = 2.38 in

General Information:

=====

File Name: untitled.col  
 Project:  
 Column: Engineer:  
 Code: ACI 318-02 Units: English  
  
 Run Option: Investigation Slenderness: Not considered  
 Run Axis: X-axis Column Type: Structural

Material Properties:

=====

f'c = 5 ksi fy = 60 ksi  
 Ec = 4030.51 ksi Es = 29000 ksi  
 Ultimate strain = 0.003 in/in  
 Beta1 = 0.8

Section:

=====

Rectangular: Width = 20 in Depth = 20 in  
  
 Gross section area, Ag = 400 in<sup>2</sup>  
 Ix = 13333.3 in<sup>4</sup> Iy = 13333.3 in<sup>4</sup>  
 Xo = 0 in Yo = 0 in

Reinforcement:

=====

Rebar Database: ASTM A615

Size	Diam (in)	Area (in <sup>2</sup> )	Size	Diam (in)	Area (in <sup>2</sup> )	Size	Diam (in)	Area (in <sup>2</sup> )
# 3	0.38	0.11	# 4	0.50	0.20	# 5	0.63	0.31
# 6	0.75	0.44	# 7	0.88	0.60	# 8	1.00	0.79
# 9	1.13	1.00	# 10	1.27	1.27	# 11	1.41	1.56
# 14	1.69	2.25	# 18	2.26	4.00			

Confinement: Tied; #3 ties with #10 bars, #4 with larger bars.  
 phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

Layout: Rectangular  
 Pattern: All Sides Equal (Cover to transverse reinforcement)  
 Total steel area, As = 15.24 in<sup>2</sup> at 3.81%  
 12 #10 Cover = 2 in

Control Points:

=====

Bending about	Axial Load P kip	X-Moment k-ft	Y-Moment k-ft	N.A. depth in
X @ Pure compression	1657.3	-0	-0	54.75
@ Max compression	1325.8	194	0	21.59
@ fs = 0.0	1039.2	315	0	16.99
@ fs = 0.5*fy	696.3	404	0	12.63
@ Balanced point	425.0	456	0	10.06
@ Tension Control	128.3	532	0	6.37
@ Pure bending	-0.0	481	0	5.45
@ Pure tension	-823.0	-0	-0	0.00
-X @ Pure compression	1657.3	-0	-0	54.75
@ Max compression	1325.8	-194	-0	21.59
@ fs = 0.0	1039.2	-315	-0	16.99
@ fs = 0.5*fy	696.3	-404	0	12.63
@ Balanced point	425.0	-456	-0	10.06
@ Tension Control	128.3	-532	-0	6.37
@ Pure bending	-0.0	-481	-0	5.45
@ Pure tension	-823.0	-0	-0	0.00