

DENNIS V. WALTER JR. | CONSTRUCTION MANAGEMENT

# PHASE 2 NEW BUILDING, JOHN TYLER COMMUNITY COLLEGE

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## TECH ASSIGNMENT #3

Thesis Advisor: Chris Magent

12/1/2009



Image courtesy of Burt Hill

[Special thanks to the Gilbane Project Team, Burt Hill, and John Tyler Community College]

# Phase 2 New Building

## John Tyler Community College, Midlothian Campus

### Midlothian, VA

#### PROJECT TEAM:

##### Owner:

Virginia Community College Systems

##### CM:

Gilbane

##### Architect:

Burt Hill

##### Civil Engineer:

Burgess and Niple

##### Structural Engineers:

Stroud Pence

##### MEP Engineers:

H.CYU Engineers

##### Telecommunications/Audio-Visual/Acoustics Engineers:

Shen Milsom Wilke

##### Cost Estimating Consultant:

Construction Consultants, Inc.

#### PROJECT OVERVIEW:

**Function:** Mixed Use Academic Building

**Size:** 60,000 SF Total, 61,001 Net SF

**Height:** 3 Stories

**Construction Dates:** May 2008 – October 2009

**Delivery Method:** CM @ Risk w/ GMP Contract

**LEED® :** Pursuing LEED® Silver Certification



#### STRUCTURAL SYSTEM:

**Foundation:** Reinforced concrete shallow spread footings, Below grade perimeter cantilevered concrete foundation walls, 4" ground floor slab-on-grade

**Framing:** Elevated slabs (4" lightweight 4000psi concrete over 1 1/2" x 20 gauge VLR composite deck) and roof deck (4" normal weight 4000psi concrete over 1 1/2" x 22 gauge type B composite deck) supported by typical W16 floor beams and W10 columns.

**Façade:** Masonry veneer backed up by a cold formed stud curtainwall, CMU (stair and elevator towers), precast concrete and metal paneling w/ steel stud

**Roof:** Steel roof decking supported by steel bar joists, beams, and columns

#### MECHANICAL SYSTEM:

- (4) 12,500 CFM AHU's serving Laboratory, Library, Classroom, and others on North End
- (1) 3,750 CFM AHU serving Office/Admin area on South End
- (4) 80 Ton Modular Chillers
- (1) 675 GPM Cooling Tower
- (2) 170 GPM Multi-Zoned Gas Fired Hot Water Storage Heaters
- (2) 1,200 MBH Hydronic Boilers constructed adjacent to Chilled Water Plant

#### SUSTAINABLE FEATURES:

- Green roof to filter and absorb rainwater, and reduce heat island effect while insulating the building.
- "Cool" Light Color Roofing to further reduce heat island effect at unplanted areas
- Modular chillers in the mechanical room eliminates the use of oil for the primary cooling equipment in the building
- Recycled content used in building materials such as drywall, fly ash in the concrete, and carpeting
- Natural daylighting sources reduce electrical consumption
- Energy efficient glass and motorized sunshades control solar heat gain, and allow solar shading
- Thermostats in every office to maximize occupants thermal comfort and control

#### ELECTRICAL SYSTEM:

- 968.2 kW Total Connected Load
- 842.3 kW Total Demand Load
- (1) 150 kW Generator
- 277 V Majority of Lighting System

#### ARCHITECTURE:

The exterior of the building is a combination of brick, precast concrete accents, metal panels, aluminum windows and an aluminum framed curtain wall complementing existing buildings on the Midlothian Campus. The layout of the building is designed to accommodate the science department, a library, student lounge, bookstore, and multipurpose room. Science labs on the third floor are the driving force for the building shape. The second floor is the primary entrance of the building from the north, and houses the library. The first floor has an entry on the south to accommodate the newly added south parking lot and contains the bookstore, multipurpose room and the student lounge.

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special thanks to Burt Hill and Gilbane for photos and data

e-Portfolio: <http://www.engr.psu.edu/ae/thesis/portfolios/2010/dxw5004/index.html>



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## **Executive Summary**

Technical Assignment 3 takes a look at areas of the John Tyler Community College Phase 2 New Building project that are possible candidates for research, alternative methods of construction, value engineering, and schedule compression. There are many ideas within this report that will be important for the final thesis proposal.

Constructability challenges are summarized based on an interview with the project team. The major issues with constructability in this project were the through-wall flashing on the exterior brick wall system, the vapor barrier of the exterior wall system, the steel erection process, and the north concrete retaining wall. The schedule acceleration ideas are then discussed including the critical path and there are several key areas of concern. Also, methods for how the schedule is accelerated if delays were to take place in the construction process are discussed. A section on value engineering topics is also included which covers many ideas that were used on this project in addition to several value engineering ideas that were not implemented.

Based on constructability challenges, schedule acceleration scenarios, and value engineering topics, the most problematic features of the building are identified and discussed. Four of these areas are then taken into further detail for opportunities as analysis activities for a thesis project. These four topics include an analysis of the brick façade, the roof, Building Information Modeling (BIM), and energy efficiency.

## Constructability Challenges

### *Through-Wall Flashing*

The construction detail of the through-wall flashing, which appear at brick façade edges on shelf angles and around windows and sills, was one of the most problematic constructability issues. The drip edge termination was detailed and specified by the architect to be stainless steel. The stainless steel detail has an exposed metal drip edge which has typically been found to be aesthetically unpleasing in the past. Also, the installer has tolerances affecting the aesthetics and length of the exposed metal which, once installed, can be extremely costly to remove because cutting is nearly impossible.

The CM decided to hold a meeting to discuss the practicality of this detail, and proposed changing the flashing and drip edge material to be flexible rubber which would ease the constructability and be more aesthetically pleasing. There was a mock-up done of the drip edge detail at a typical sill location. The flexible rubber material was then accepted for use where the stainless steel was originally called for.

This issue was solved prior to any installations and the mock-up was successful in determining the proper detail of the through-wall flashing and drip edge.

Please see **Appendix A: Flashing Detail** for details of the through-wall flashing design.

### *Vapor Barrier*

Because of the water leak problems on the Midlothian Campus' existing building facades, the vapor barrier on this building was a major constructability problem. The typical Tyvek vapor barrier was deemed to be unsatisfactory and low budget for this building so the project called for a fluid applied vapor barrier to be applied over the exterior sheathing of the building. The drywall contractor was contracted to perform this. The specs called for applications to be applied at a 120-mil (3.0mm) wet film thickness. The drywall contractor was told by the manufacturer of the fluid applied vapor barrier that rolling the material onto the sheathing would provide acceptable millage. The project team soon discovered that rolling the vapor barrier was not the correct means of application. The problem was discovered when the product manufacturer's representative did an inspection and found the millage to be insufficient. A section of wall that was 95% completed with brick veneering had to be torn down to correct the issue.

To solve this issue, the CM brought in every contractor whose scope of work dealt with the building envelope as well as the product manufacturer's representative. They discovered that the specs were calling for way too much material. The CM wrote an RFI and it was accepted to bring the wet film thickness down to 60 mils. The brick mason had to remove the area of wall which they had already completed the brick on. The drywall contractor had to hire a painter to spray on the material at the correct millage. The product manufacturer's representative inspected the sprayer and the spray-on application before accepting the new application method. The project team had developed an inspection protocol to follow for every area of the building as it became available for the vapor barrier application. The drywall contractor had to pay for the brick mason's time for removing brick on the North elevation which was completed over the incorrect millage.

The project team learned that a benchmark inspection for the first application of the vapor barrier should be completed to determine that the material is being installed correctly at the specified thickness. The schedule was slightly affected due to the inspection criteria, and a recovery schedule was compiled and followed for completing the building envelope on time.

Please see **Appendix B: Vapor Barrier** for photos of the installation.

### ***Steel Erection***

The steel erection had gone smoothly, until the QC of the erection. The QC on checking the correct levelness and plumb was not done properly until near the end of the erection. The steel structure was leaning and severely out of plumb. The anchor bolts were off by ½ inches in several locations which slowed the construction.

The CM learned that the steel erector's level had not been properly calibrated prior to the erection process. This was discovered when a 3<sup>rd</sup> party inspector came in to survey and confirm that the steel were correctly plumb.

### ***Retaining Wall***

The retaining wall on the north end of the building was designed with a crushed stone backfill on the contract drawings. This was overlooked in the estimating and purchasing of the materials for the retaining wall. During the construction of the retaining wall, the contractor had to purchase the additional crushed stone backfill. There was a significant amount of material that had to be purchased and delivered to site. The stone had to be filled at a depth of 18 feet and angled back at 45 degrees. This caused an increase in cost and small schedule delay in the completion of the retaining wall backfill.

## Schedule Acceleration Scenarios

### Overview

The construction schedule was created based off a list of key milestone dates that were known to be important for keeping the project on schedule. This milestones were tracked and used as small completion dates within the overall project schedule, and work sequences leading up to these key milestone dates could be modified or accelerated within the schedule if any delays would occur.

<b>Milestones Tracking</b>	
<b>Milestone</b>	<b>Target Date</b>
Milestone #1 - Building Pad Ready	06/09/08
Milestone #2 - Begin Foundations	07/03/08
Milestone #3 - Start Steel	09/01/08
3.1 Start Masonry Shafts (Act ID 1490)	09/23/08
3.2 Start 2nd Floor Concrete on Deck (ACT ID 1390)	10/07/08
3.3 Start Exterior Skin (ACT ID 1560)	10/16/08
Milestone #4 - Complete Steel & Concrete Structure	10/31/08
Milestone #5 - Building Dried-In (Temporary)	01/29/09
Milestone #6 - Façade Complete	02/18/09
6.1 Elevator 1 & 2 Complete (ACT ID E2010)	03/13/09
Milestone #7 - Permanent Power	01/01/09
Milestone #8 - Conditioned Air Available	03/31/09
<b>3rd Floor Milestones</b>	
Hang & Finish GWB (Finish)	02/26/09
Prime & First Coat Paint (Finish)	03/05/09
Hang Ceiling Grid (Start)	03/09/09
Ceiling Tile (Start)	04/24/09
Install Laboratory Casework (Start)	04/06/09
Test & Balance (Start)	05/01/09
<b>2nd Floor Milestones</b>	
Hang & Finish GWB (Finish)	03/12/09
Prime & First Coat Paint (Finish)	03/19/09
Hang Ceiling Grid (Start)	03/26/09
Ceiling Tile (Start)	05/11/09
Test & Balance (Start)	05/18/09
<b>1st Floor Milestones</b>	
Hang & Finish GWB (Finish)	03/26/09
Prime & First Coat Paint (Finish)	04/02/09
Hang Ceiling Grid (Start)	04/07/09
Ceiling Tile (Start)	05/21/09
Test & Balance (Start)	06/01/09
<b>Mechanical Room &amp; Roof Milestones</b>	
Mechanical Room Piping (Finish)	04/03/09
Test & Balance - Water Global (Start)	06/22/09
Electrical Connections of Mech. Equipment (Finish)	04/10/09
Electrical Connections for Rooftop Equip (Finish)	04/15/09
<b>Substantial Completion</b>	
Fire Alarm Installation Complete	06/01/09
Fire Alarm Pre Test Complete	06/15/09
State Fire Marshall Final Inspection	06/22/09
Elevator Final Inspection	06/24/09
TAB Report for Air Balance ready	06/19/09
BCOM Final Inspection	06/29/09

Figure 1: Milestone Tracking List

### ***Critical Path***

The critical path of the construction schedule is the most important sequence for completing the project on time. The critical path began with getting the steel purchased and delivered to site in time for erection. The steel milestone was to begin the erection of the steel by September 1, 2008. To ensure that the steel was guaranteed to start on time was to get the mill order made early with completed shop drawings, fabrication completion at the steel fabrication shop, and materials delivered and sequenced in the correct erection order all before the first day of erection. The exterior façade also was a major component of the critical path. The milestone of completing the exterior façade was on February 18, 2009. The exterior façade completion affected the major building dry-in date which has to be completed before a majority of the interior finishes can be complete and when commissioning occurs. The construction of the exterior façade had been affected by weather which changed the order of some of the construction sequencing in order to complete the milestone on time without affecting the critical path. Another major critical path item was all of the internal rough-ins of plumbing, mechanical, and electrical.

### ***Contingency***

The project was a GMP agreement, which had a contingency built-in. This would allow for overtime to be paid in the event of schedule delays. The contingency was used to accelerate the MEP rough-ins above ceilings which had been delayed and was part of the critical path. The schedule was not delayed because the overtime had accelerated the schedule to meet the milestone for ceiling close-in inspections.

### ***Exterior Façade/Building Envelope***

Acceleration of the building envelope and exterior facade would be one major consideration for accelerating the schedule if necessary. The closing in of the building is a major milestone which must be done before major interior trades can begin or complete their work. This alternative, however, could not be done due to the fact that the shortage of manpower for the curtain wall system had existed with the curtain wall contractor.



## **Value Engineering Topics**

The Value Engineering that was performed on this project were intended to provide the John Tyler Community College with a reduced building cost while maintaining the quality of building they expected and not detracting from their goals, keeping LEED® implications in mind.

One major item left out of the contract, which is typically preferred within Gilbane's contract, is Gilbane's Document Coordination Service. Gilbane would normally provide document coordination as an additional service to help coordinate the mechanical and electrical documents between trades. This is an interdisciplinary document control service that was left out of the contract to save in total cost. Therefore, the mechanical and electrical documents were not closely coordinated through Gilbane's project management team.

Listed below are several value engineering or cost saving suggestions that were accepted, as well as several that were not implemented into this project:

### ***Reduce Design Contingency to 7.5%***

Cost Savings: \$435,960

✗ Not Implemented

### ***Reduce Building Height by 24" on 2<sup>nd</sup> Floor***

Cost Savings: \$74,552

✓ Accepted

### ***Reduce Building 2000 SF @ \$288/sf***

Cost Savings: \$576,000

✓ Accepted

### ***Owner Pays Consumption Charges During Construction***

Cost Savings: \$96,863

✓ Accepted

### ***Eliminate Mechanical Screen***

Cost Savings: \$221,400

✓ Accepted

### ***Eliminate Green Roof***

Cost Savings: \$196,406

✗ Not Implemented

### ***Change Monumental Stair and Rail to Metal Pan Stair***

Cost Savings: \$39,360

✓ Accepted

***Use Brick in lieu of Precast***

Cost Savings: \$127,949

✓ Accepted

***Shelf Angle Detail***

Cost Savings: \$43,050

✓ Accepted

***Tyvek Instead of Spray-On Insulation w/ Air Barrier***

Cost Savings: \$79,139

✓ Accepted

***Eliminate Gypsum Ceilings***

Cost Savings: \$9,072

✗ Not Implemented

***Eliminate Bulkheads***

Cost Savings: \$7,380

✗ Not Implemented

***Change 2x6 Ceiling to 2x4***

Cost Savings: \$32,557

✗ Not Implemented

***Change 2x6 Ceiling to 2x2***

Cost Savings: \$19,508

✓ Accepted

***Eliminate Terrazzo, use VCT***

Cost Savings: \$196,994

✓ Accepted

***Eliminate Epoxy Paint for Latex***

Cost Savings: \$19,701

✓ Accepted

***Reduce Impact Resistant Drywall to 8'***

Cost Savings: \$10,455

✓ Accepted

***Change Column Covers in Library to Drywall***

Cost Savings: \$29,520

✓ Accepted

***Reduce Canopy by ½***

Cost Savings: \$68,082

✓ Accepted

***Reduce Library and Student Lounge Millwork***

Cost Savings: \$61,500

✗ Not Implemented

***Reduce Lab Casework***

Cost Savings: \$113,160

✓ Accepted

***Owner Fund Projection Screens and Blinds***

Cost Savings: \$93,989

✓ Accepted

***Eliminate Acid Neutralization System***

Cost Savings: \$6,330

✓ Accepted

***Eliminate Hard Wired Electronic Flush Valves for Toilets, Sinks, etc.***

Cost Savings: \$41,574

✗ Not Implemented

***Reduce Number of Lab Exhaust Fans***

Cost Savings: \$65,927

✓ Accepted

***Reduce Number of VAV Boxes***

Cost Savings: \$3,979

✓ Accepted

***Combine AHU's into 3 Units***

Cost Savings: \$74,194

✓ Accepted

***Use Conventional Chiller Unit***

Cost Savings: \$158,633

✓ Accepted

***Reduce Custom Light Fixtures***

Cost Savings: \$51,831

✓ Accepted

***MC Cable for Lighting***

Cost Savings: \$33,210

✓ Accepted

***Aluminum Feeders***

Cost Savings: \$17,220

✓ Accepted

***Eliminate Generator***

Cost Savings: \$36,900

✗ Not Implemented

***Use MC Cable for Small Power Applications***

Cost Savings: \$12,300

✓ Accepted

## **Problem Identification**

### ***Brick Wall Exterior Façade***

Brick or masonry facades are a very common exterior wall system. There is a great deal of time spent and coordination issues that come into play when construction of the wall system occurs. The detail of the through-wall flashing drip edge and the spray on vapor barrier are good examples of a headache for the project team when it comes to constructability and functional and aesthetic quality. Alternative solutions to a typical brick façade and wall detail include precast brick paneling or thin brick veneers. Such systems may have more simple design details, saving time and money.

### ***Steel Shakeout/Plumb/Leveling***

As stated before, the steel erection had gone smoothly, until the QC of the erection. The QC on checking the correct levelness and plumb was not done properly until near the end of the erection. The steel structure was leaning and severely out of plumb. The anchor bolts were off by ½ inches in several locations which slowed the construction. The CM learned that the steel erector's level had not been properly calibrated prior to the erection process. This was discovered when a 3<sup>rd</sup> party inspector came in to survey and confirm that the steel were correctly plumb. Research may suggest that proper coordination and steps leading up to the steel erection process can ease the construction and quality control of the superstructure's erection.

### ***Steel Decking***

The structural engineer specified a 1.5 VLR composite metal deck for the elevated slabs of the building. The correct decking was delivered, but installed "up-side down" by the steel erectors. After a quick calculation by the structural engineer, it was determined that the decking could remain as installed. It would have been a very costly mistake if the difference would have impacted a large quantity of concrete to be poured, which affects the dead load of the deck and the structural capacity it can handle.

### ***Transformer Phase Loss***

The 300kVa Transformer that was specified by the power company suffered a loss of Phase "A" power. This phase loss caused severe damage to the building automation system. Many of the contracts for the VFD's were fried. This occurred several days prior to the Phase 2 New Building's First Day of Classes. The approved removal of phase protection by the Electrical Engineer is what made the phase loss occur. The electrical engineer and electrical power company never verified the service load and transformer sizing would be sufficient. The power company had to change the 300kVa transformer out for a 750kVa and an insurance claim was filed by the CM.

### ***LEED® Online***

The LEED Online would not allow team members to be altered, or assigned to a credit while the project is in a review phase. This situation would commonly occur when a project gains a new LEED team member during a review stage, and that new member would not be able to upload or alter any documentation for their assigned credits. There must be a plan in place to address this situation if there is an expected addition or loss of a team member on a project.

***Roofing***

The majority of the roof is a green roof system. During the value engineering process, a light colored EPDM roofing system with ballast was mentioned but not pursued further for cost impact analysis. Keeping LEED® in mind since this project is pursuing LEED® Silver Certification, the roofing system provides an opportunity to reduce construction cost, improve environmental impact, and still maintain the LEED® points associated with the green roof that was installed.

## **Technical Analysis Methods**

### **Brick Façade**

The hand-laid brick façade is a very common exterior wall type, it caused several headaches on site dealing with the detail of the through-wall flashing and drip edge, as well as the application of a spray-on vapor barrier. This caused several schedule delays, and had potential for coordination and site logistic issues. Because the exterior enclosure milestone is required to begin interior fit-outs, accelerating the façade would keep delays from occurring.

#### ***Benefits:***

A hand laid brick exterior wall system requires a high amount of detail and can be a complex wall system to install. The brick wall may also require a large amount of scaffolding and area near the building envelope during the installation process. Precast systems can eliminate this need for a mortar station and constant stocking of brick for installation. There are a large amount of workers required to keep the brick installation moving along, which increases the need for safety and coordination of manpower. Also, precast exterior facades reduce labor costs and installation time. The majority of preparation for a precast façade can be done off site in a climate controlled environment. Additionally, a precast brick exterior façade can take the place of each individual part of the wall acting as an entire wall system, and it can reduce the number of detailing issues and installation issues that could occur in the field.

#### ***Drawbacks:***

Precast systems are normally less flexible in design and aesthetic quality compared to a hand-laid brick wall. The design for the Phase 2 New Building required a match of the existing campus features with an emphasis on a quality appearance and an exceedingly watertight enclosure. Also, the joints between the precast panels and exterior curtain walls would need close attention. Precast systems have joints between the panels, which require close attention in the field during construction. To ensure these joints are properly closed with a quality seal, a successful mock-up would need to be constructed and tested for watertight assurance and quality aesthetic appeal.

#### ***Analysis:***

The focus of study will be on the schedule acceleration associated with a precast brick wall system and the cost impacts. The system would have to be easier to install, with a more simple design and detail of joints and waterproofing. There must still be a quality equal or better than a hand laid system. This analysis will include durability, aesthetics, and constructability. Also, the structural and architectural differences will be looked at. Research would have to start with learning about the different precast wall systems available. Also, industry professionals would be consulted for opinions and knowledge of the various precast systems. The most successful precast system will be selected as the best candidate for analysis. Analysis will include cost, schedule, constructability, and local availability.

## **Roof**

The current green roof system could be looked at for a more practical or more “green” product. There certainly are less expensive roofing alternatives that provide similar “green” requirements for LEED and can result in greater long-term cost savings. The different systems include a wide variety of green roof systems as well as lighter “cool” white roofing systems.

### ***Benefits:***

There are many innovative and inexpensive new roofing systems on the market that can provide excellent thermal insulation and as well as reducing energy costs and minimizing environmental impact. There are green roof systems that can be used for rain water harvesting or light “cool” roof systems with excellent UV reflectance properties.

There are new products on the market that can provide an excellent life-cycle cost savings and may benefit the John Tyler Community College in looking at cost savings over a long-term building life.

### ***Drawbacks:***

The many alternative roofing systems are new and cannot provide a guaranteed assurance of longevity of the system. Also, there are many “green” products that do not get manufactured in an environmentally friendly process. These drawbacks must be considered when selecting a new green technology that has not yet been a proven success in a large number of applications.

### ***Analysis:***

The roofing system analysis must begin by learning about the many alternative green roof systems as well as the many “cool” white roof systems. It must be decided whether rain water harvesting through a different green roof system may be desirable for the Phase 2 New Building, or whether a “cool” light colored roof would be a better alternative through its greater reflectance of UV and lower temperature absorption. The comparison between the two systems will have to include costs, schedule, constructability, and environmental impact. Depending on the selected system, this analysis could involve a structural analysis or mechanical analysis if the system significantly changes structural loads or can harvest a large amount of rain water for use in the building.



## **Building Information Modeling**

Because Building Information Modeling is becoming a quickly growing tool in the construction industry, it may be beneficial to look at the benefits or drawbacks that may occur by implementing the use of BIM on this project.

### ***Benefits:***

The contract with the CM, Gilbane, had left out Gilbane's Document Coordination Service, which would normally be included as a service to help coordinate the mechanical and electrical documents between trades. The incorporation of BIM may have added value to the project for the purpose of discovering trade coordination issues before they arose in the field. The Phase 2 New Building could have benefited from 3D MEP Coordination due to the larger amount of mechanical, electrical, and plumbing work that was required for the 3<sup>rd</sup> floor laboratories. Also, the owner, John Tyler Community College, could use the As-Built BIM Model as a learning tool in conjunction with the Building Automation System that is already incorporated into the building systems.

### ***Drawbacks:***

There have not been many studies to show how much improvement is gained from BIM use. The project may be too "small" for a BIM Model to show significant improvement in the project's outcome. The original architectural model created may need a large amount of detail added in order for the BIM model to give desirable outcomes. Also, the ability of the local trades and contractors to contribute to the BIM model may be limited or unavailable due to BIM still being relatively new to some smaller contractors.

### ***Analysis:***

Analysis may have to begin with researching anecdotal evidence and case studies that can highlight BIM's major benefits on similar projects to the Phase 2 New Building. It could be possible to analyze possible gains from multiple uses a BIM model can create. The development of a BIM model may help accurately gauge the level of detail needed for desirable outcomes. Impacts of implementing BIM could potentially help decrease the amount of field issues occurring between MEP trade coordination, and could provide the John Tyler Community College with a "learning" tool by combining an As-Built BIM model and the Building Automation System.

## **Energy Efficiency**

There are billions of dollars spent on energy each year by colleges and universities. By adopting a more energy efficient mechanical system and using more renewable energy sources, energy use can be reduced significantly. With the opportunities available for renewable energy sources such as solar or geothermal in Midlothian, VA, there could be significant cost savings for John Tyler Community College by implementing efficient renewable energy sources. There are also opportunities for purchasing “green power” from the grid.

### ***Benefits:***

By incorporating a more energy efficient mechanical system or by utilizing on-site renewable energy sources could show significant cost savings over the building life-cycle. The additional purchasing of green power from the local power company can also benefit the environmental impact of the building’s energy usage. Also, the purchasing of green power is another way to reduce the negative environmental impact of traditional electrical power plant sources.

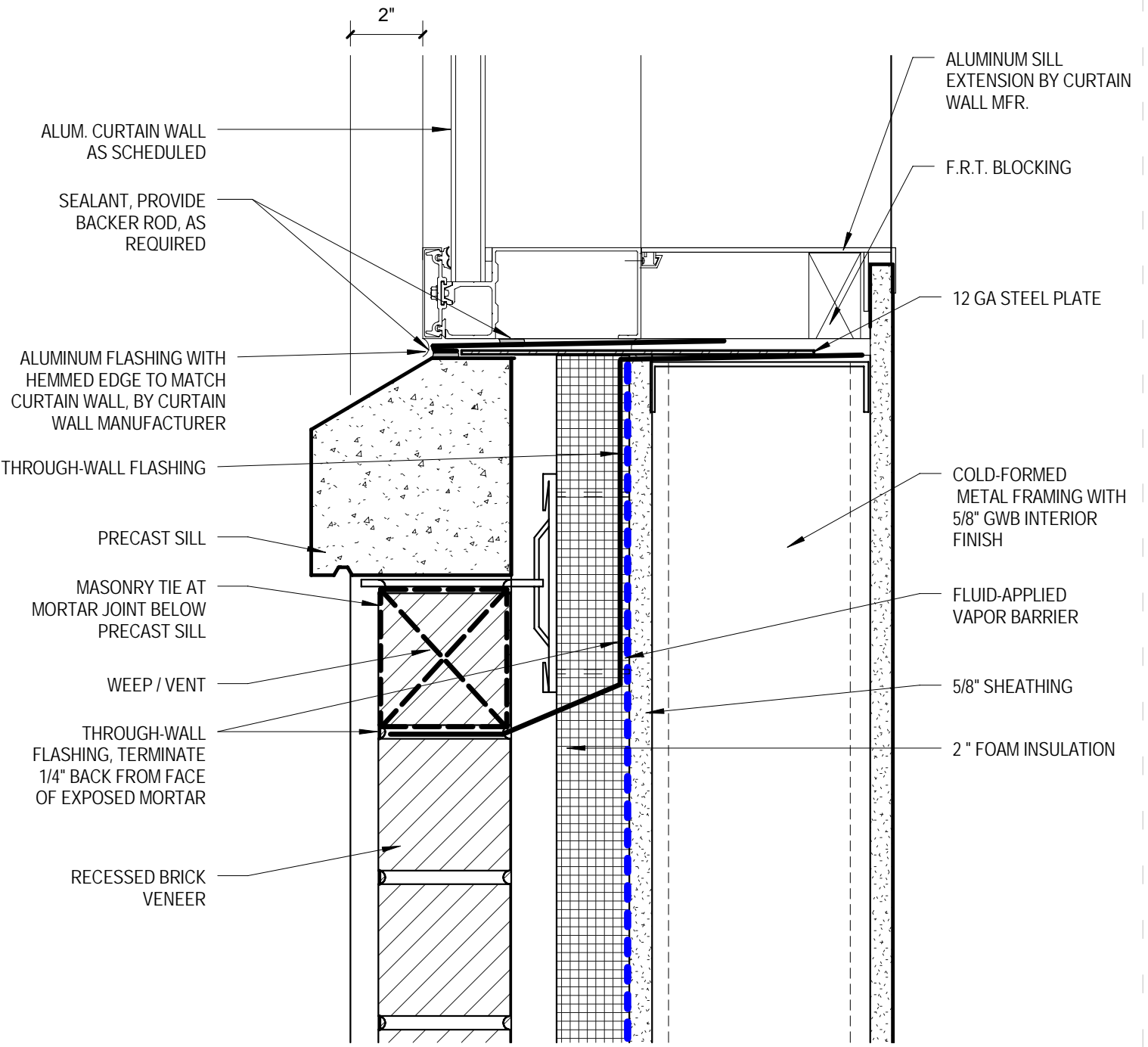
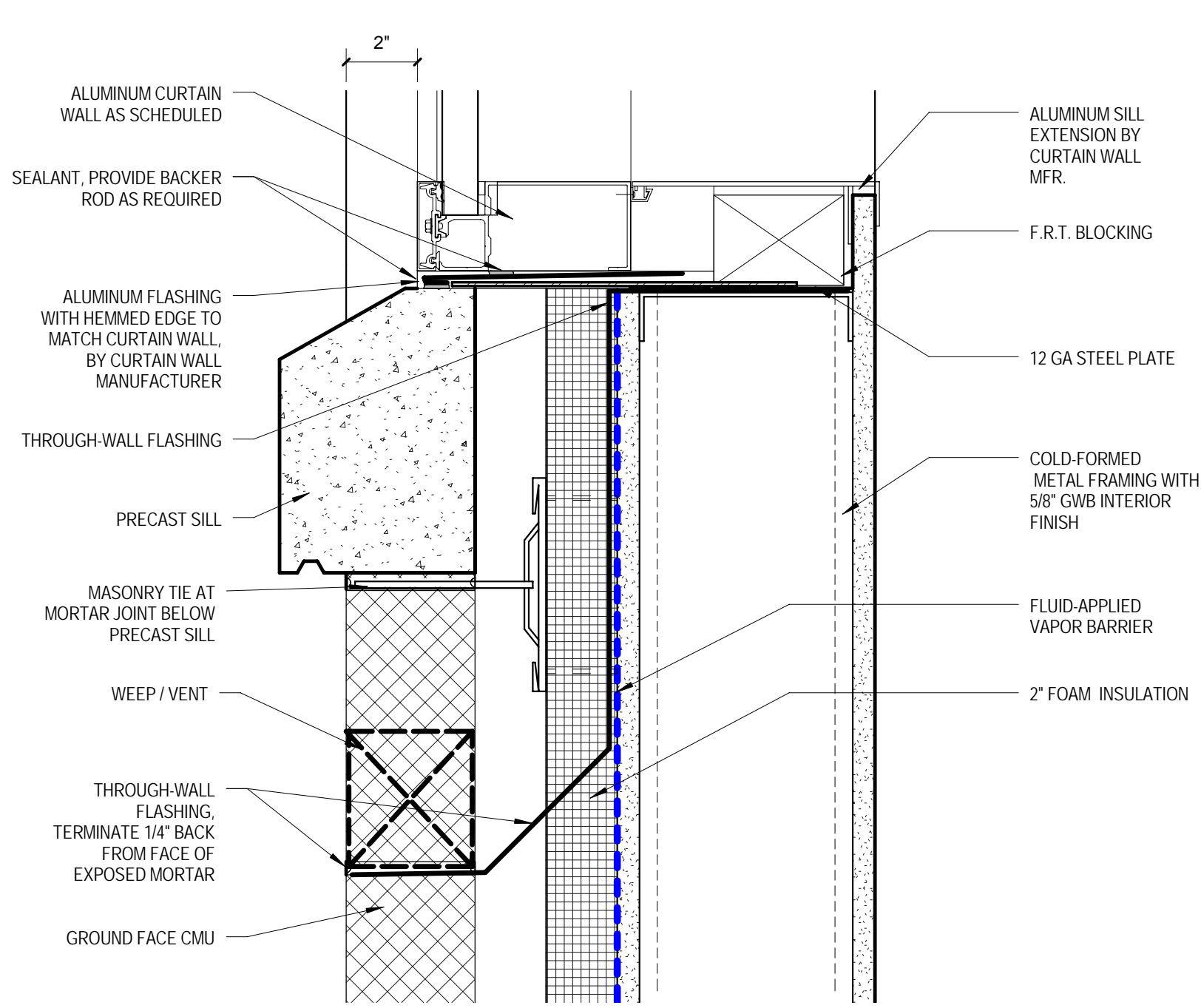
### ***Drawbacks:***

The incorporation of on-site renewable energy sources or more efficient mechanical system may add a higher level of complexity to the project. The building systems would have to be more closely coordinated during the installation of these products or system to ensure the level of quality and efficiency is not lost during construction. There are many higher initial costs associated with newer or more complex systems, and the pay-back period may not be short enough to be a convincing positive change to the building. Also, there is no guarantee that these energy efficient systems will be able to provide the expected level of efficiency or operation once in place. Additionally, green power plans can be expensive and depending on location, may not always be available.

### ***Analysis:***

First, the analysis would have to review the possible changes in mechanical system to a more efficient system. Also, there would have to be research on the availability and efficiency associated with using on site renewable resources such as geothermal or solar power. Consulting industry professionals on the best applications for energy efficient systems would be viable for determining the best system or energy efficient products for use on this project. A life-cycle cost comparison would be completed to determine if the proposal of switching to a more efficient mechanical system or utilizing renewable energy resources would show significant cost reductions in energy bills.

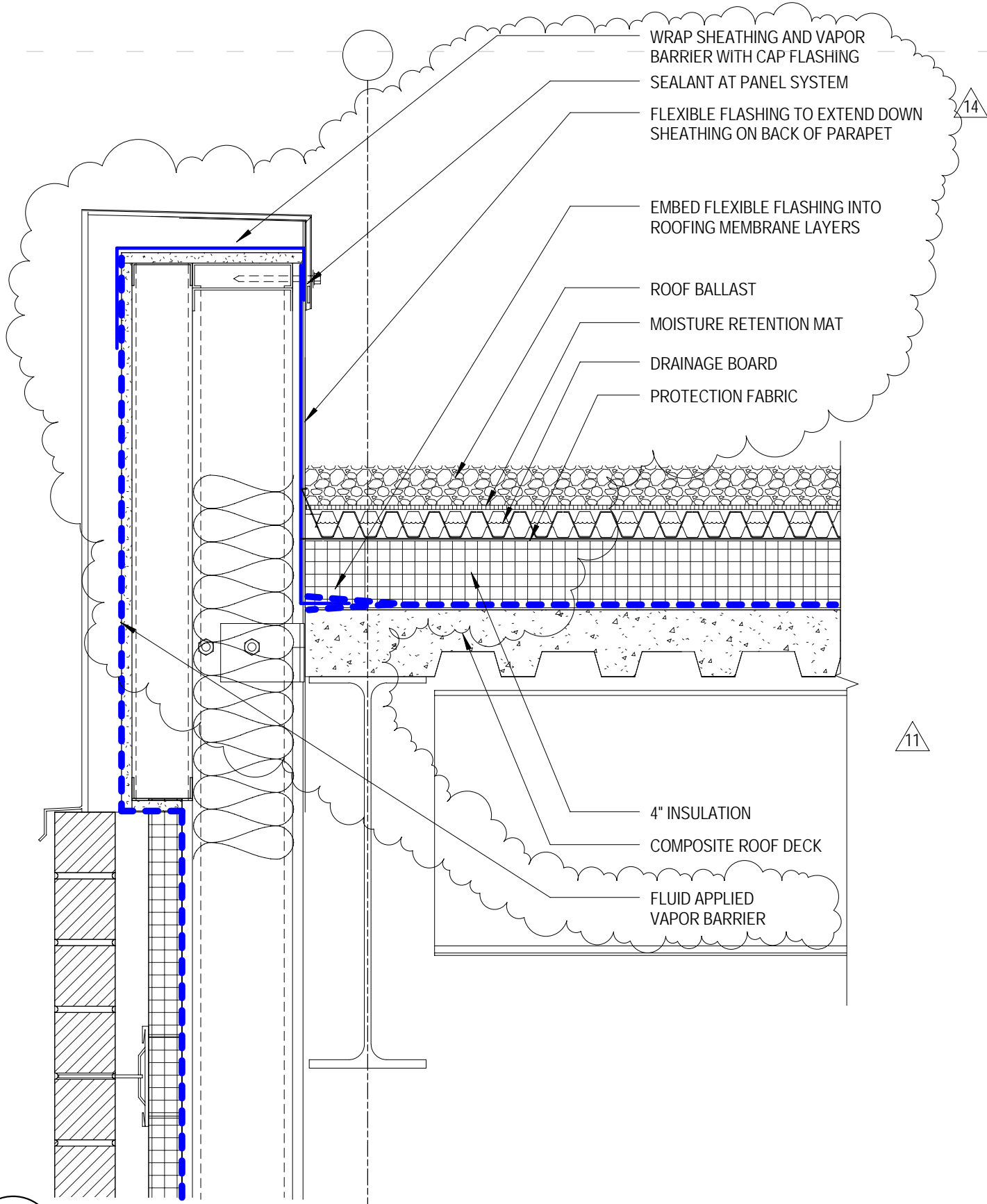
## **Appendix A: Flashing Detail**



**E1** DETAIL - ALUM. WINDOW SILL @ BLOCK VENEER  
 SK - A732.2 3" = 1'-0"

**C6** ENLARGED DETAIL - ALUM. WINDOW SILL  
 A731 SK - A732.2 3" = 1'-0"

Project <b>JOHN TYLER COMMUNITY COLLEGE</b> JOHN TYLER COMMUNITY COLLEGE - MIDLOTHIAN PHASE 2	Drawing Title <b>ENLARGED SILL DETAILS</b>	<b>BURT, HILL</b> 1056 Thomas Jefferson Street NW Washington DC 20007 TEL: 202 333 2711 FAX: 202 333 3159 www.burthill.com	Drawing Number <b>SK - A732.2</b>	
			VA Project Code #: 260-17386	Issue Date: 12/09/08
			BH Project No.: 0660800	Issued With: B.022/RF1 156
			Scale: 3" = 1'-0"	Reference Sheet: A732



WRAP SHEATHING AND VAPOR BARRIER WITH CAP FLASHING  
 SEALANT AT PANEL SYSTEM  
 FLEXIBLE FLASHING TO EXTEND DOWN SHEATHING ON BACK OF PARAPET

EMBED FLEXIBLE FLASHING INTO ROOFING MEMBRANE LAYERS

ROOF BALLAST  
 MOISTURE RETENTION MAT  
 DRAINAGE BOARD  
 PROTECTION FABRIC

4" INSULATION  
 COMPOSITE ROOF DECK  
 FLUID APPLIED VAPOR BARRIER

14

11

**3** TYPICAL PARAPET EDGE

SK - A951.1 1 1/2" = 1'-0"

Project <b>JOHN TYLER COMMUNITY COLLEGE</b> JOHN TYLER COMMUNITY COLLEGE - MIDLOTHIAN PHASE 2 Drawing Title <b>PARAPET EDGE CONDITION</b>	<p style="text-align: center;"><b>BURT, HILL</b></p> 1056 Thomas Jefferson Street NW Washington DC 20007 TEL: 202 333 2711 FAX: 202 333 3159 www.burthill.com	VA Project Code # : BH Project No. : 06608.00 Scale: 1 1/2" = 1'-0" Issue Date: 10/16/08 Issued With: BULLETIN 014 / RFI 0097 Reference Sheet: A951	Drawing Number <p style="font-size: 2em; font-weight: bold;">SK - A951.1</p>
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## **Appendix B: Vapor Barrier**



