

**THE EDMOOR CONDOMINIUMS**  
**BETHESDA, MARYLAND**

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***Project Overview***

The Edgemoor Condominiums are located in downtown Bethesda, Maryland on the corner of Woodmont Ave. and Montgomery Lane. The property is prime real estate located half a city block from the Bethesda Metro Station and dozens of shops, restaurants, and office buildings.

The building is a 10 story structure containing 54 condominiums, 3 below-grade parking levels, fitness center, and a party room. Floors 2 through 8 have a typical floor plan consisting of 6 units per floor. The 9<sup>th</sup> and 10<sup>th</sup> floors have only three units per floor.

***Table 1 – Edgemoor Square Footage Breakdown***

Garage Area (SF)	48,665
Superstructure Area (SF)	114,595
Residential Unit Area (SF)	98,600
Number of Units	54
Cost per Unit	\$350,343
Net SF per Unit	1,826
Total Area (SF)	163,300
Cost per SF	\$115.85

The units are divided into several different layouts for the typical floors there are 6 different layouts; H, L, E, F, J, and I. each tenant is then given the choice of several different finishes to customize the new home. Choices include items such as Oak or Bamboo flooring, various patterns of ceramic or marble tile, and cherry, maple, or white kitchen cabinets to name a few.

## **THE EDGEMOOR CONDOMINIUMS**

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### **BETHESDA, MARYLAND**

Customer satisfaction is a major contributor to schedule delays due to change orders in the form of Quality Assurance Directives or QAD's for short. The addition of QAD's well into the construction of a particular unit posed a big challenge to the construction management staff to keep the project schedule.

PN Hoffman targets a middle age upper class demographic that generally prefers a contemporary industrial atmosphere. The older clientele of the Edgemoor are seasoned home owners and demanded a slightly different structure going for a more traditional appearance. The ten by using traditional double-hung windows, red brick, decorative precast stone on the lower levels and an elegant Mansard roof. Traditional interior features include paneled doors, crown molding, large flat base-board on all walls.

Using pre-cast stone on the first two floors to aesthetically support a traditional red brick veneer on the remaining eight levels. Precast-Stone was also used for window headers and sills. Continuing the Precast stone appearance at the top of the structure is FRP or Fiberglass Reinforced Plastic. The use of this material greatly reduces cost and without sacrificing appearance.

Balconies, a major amenity in downtown living, are the Edgemoor's most noticeable feature from the ground. The balconies are "Juliet Balconies" meaning that upon opening the balcony door which opens inward, there is only enough room to stand in the doorway and lean on the railing for a good view of downtown Bethesda.

The structural system of the Edgemoor is made up of three below grade garage level constructed of cast-in-place concrete. The superstructure was constructed using cast-in place columns with post-tensioned concrete slab to allow for columnless units.

**THE EDMOOR CONDOMINIUMS**  
**BETHESDA, MARYLAND**

*Table 2 - Project Cost Summary*

CSI Division No.	Description	Cost Breakdown	Cost Total
<b>01</b>	<b>General Conditions</b>	\$1,260,000	<b>\$1,260,000</b>
		\$1,260,000	
<b>02</b>	<b>Sitework</b>		<b>\$1,165,500</b>
02200	Demolition & Site Preparation	\$24,500	
02250	Support of Excavation	\$402,000	
02300	Earthwork & Excavation	\$379,000	
02500	Utility Services	\$104,500	
	Subsurface		
02600	Drainage	\$17,000	
02700	Asphalt & Site Concrete	\$99,000	
02800	Site improvement and Amenities	\$33,500	
02900	Landscaping and Planting	\$106,000	
	<b>Subtotal</b>	<b>\$1,165,500</b>	
<b>03</b>	<b>Concrete</b>		<b>\$3,351,000</b>
03310	Structural Concrete	\$3,351,000	
	<b>Subtotal</b>	<b>\$3,351,000</b>	
<b>04</b>	<b>Masonry</b>		<b>\$1,377,500</b>
04200	CMU block	\$962,000	
04250	Pre-Cast Stone	\$413,500	
04400	Stone	\$2,000	
	<b>Subtotal</b>	<b>\$1,377,500</b>	
<b>05</b>	<b>Metals</b>		<b>\$733,000</b>
05100	Structural Steel	\$25,500	
05500	Miscellaneous Metals	\$498,500	
05700	Ornamental Metals	\$209,000	
	<b>Subtotal</b>	<b>\$733,000</b>	
<b>06</b>	<b>Carpentry</b>		
06100	Rough Carpentry	\$140,000	
06200	Finish Carpentry	\$205,000	

**THE EDMOOR CONDOMINIUMS**  
**BETHESDA, MARYLAND**

06400	Architectural Woodwork	\$30,000	
06500	Plastics	\$121,000	
	<b>Subtotal</b>	<b>\$496,000</b>	<b>\$496,000</b>
<b>07</b>	<b>Thermal &amp; Moisture Protection</b>		
07100	Damproofing & Waterproofing	\$146,000	
07200	EIFS & Thermal Protection	\$174,500	
07300	Roof Pavers	\$21,500	
07400	Metal Roofing	\$173,500	
07500	Membrane Roofing	\$41,500	
07600	Flashing & Sheet Metal	\$29,000	
07700	Roof Specialties and Accessories	\$59,000	
07800	Fire & Smoke Protection	\$3,000	
07900	Exterior Joint Sealants	\$80,500	
	<b>Subtotal</b>	<b>\$728,500</b>	<b>\$728,500</b>
<b>08</b>	<b>Doors &amp; Windows</b>		
08100	Metal Doors & Frames	\$38,000	
08200	Wood Doors & Frames	\$115,000	
08300	Specialty Doors	\$8,500	
08400	Entrances	\$236,000	
08500	Windows	\$301,000	
08700	Hardware	\$103,000	
08800	Glass & Glazing	\$439,500	
08900	Testing & Cleaning	\$10,500	
	<b>Subtotal</b>	<b>\$1,251,500</b>	<b>\$1,251,500</b>
<b>09</b>	<b>Finishes</b>		
09200	Gypsum Board	\$2,341,000	
09300	Tile	\$67,500	
09400	Marble	\$285,000	
09500	Wood Flooring	\$407,000	
09600	Carpet & Resilient Flooring	\$108,000	
09900	Paints & Coatings	\$271,500	
09950	Final Cleaning	\$24,500	
	<b>Subtotal</b>	<b>\$3,504,500</b>	<b>\$3,504,500</b>
<b>10</b>	<b>Specialties</b>		
10100	Toilet/Shower Compartments	\$21,500	
10200	Louvers & Vents	\$2,000	
10300	Fireplaces	\$69,500	
10400	Building Signage	\$15,000	
10500	Fire Protection Specialties	\$6,500	
10550	Postal Specialties	\$6,000	

**THE EDGEWOOD CONDOMINIUMS**  
**BETHESDA, MARYLAND**

10800	Toilet/Laundry Accessories	\$33,000	
	<b>Subtotal</b>	<b>\$153,500</b>	<b>\$153,500</b>
<b>11</b>	<b>Equipment</b>		
11150	Parking Control Equipment	\$15,000	
11160	Loading Dock Equipment	\$105,000	
11450	Residential Equipment	\$239,000	
11480	Athletic & Recreational Equipment	\$20,000	
11910	Kitchen Cabinetry	\$327,500	
11920	Kitchen Countertops	\$124,500	
11930	Toilet Room Vanities & Tops	\$87,000	
	<b>Subtotal</b>	<b>\$918,000</b>	<b>\$918,000</b>
<b>12</b>	<b>Furnishings</b>		
12400	Furnishings & Accessories	\$1,500	
12500	Furniture	\$25,000	
	<b>Subtotals</b>	<b>\$26,500</b>	<b>\$26,500</b>
<b>14</b>	<b>Conveying Equipment</b>		
14200	Elevators	\$430,000	
	<b>Subtotal</b>	<b>\$430,000</b>	<b>\$430,000</b>
<b>15</b>	<b>Mechanical</b>		
15100	Garage Mechanical	\$255,500	
15200	Building HVAC	\$1,031,500	
15300	Building Plumbing	\$630,000	
15400	Residential Unit Plumbing Fixtures	\$270,000	
15500	Sprinkler System	\$206,500	
	<b>Subtotal</b>	<b>\$2,393,500</b>	<b>\$2,393,500</b>
<b>16</b>	<b>Electrical</b>		
16100	Sitework Electrical	\$121,500	
16200	Building Electrical	\$601,000	
16300	Sitework Electrical	\$57,500	
16400	Building Light Fixtures	\$218,000	
	Site Lighting		
16500	Fixtures	\$50,000	
16600	Security System	\$81,500	
	<b>Subtotal</b>	<b>\$1,129,500</b>	<b>\$1,129,500</b>
	<b>TOTAL</b>		<b>\$18,918,500</b>

**THE EDMOOR CONDOMINIUMS**  
**BETHESDA, MARYLAND**

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**PN Hoffman**

PN Hoffman is a high-end residential developer based out of NW Washington, DC. Most projects constructed and under construction lie within the DC area. The company acts as both owner and general contractor. The advantage to this system is that changes and modifications that normally evolve during construction can be speedily communicated and resolved in a simple e-mail or phone call.

How PNH reaches substantial completion is also unique to an owner / gc approach to construction. Due to the high level of perfection demanded by the tenants, the units under go a rigorous punchlisting and quality control by both the PH Hoffman owner division and the PN Hoffman general contractor division. After a unit has received final paint and has been punchlisted by the general contractor team, the door is locked and the keys are handed over to the QA (Quality Assurance) department.

The QA team will then conduct their very own punchlist and walk throughs with the tenant to address any remaining flaws. If touch-ups are required then the QA Department will use its own in-house crew to touch up items such as a scratch in the bamboo flooring, smudge on the final paint, and conduct a final cleaning of the entire unit.

### **Improving Schedule Efficiency**

#### **Introduction**

During the summer of 2003 the Punch Out stages of the job were beginning to start. Several issues developed as more and more finishing trades entered the job. Most of the project finishing contract went to repeat subcontractors. Some subs such as NLP who was under control of the job's main painting force have worked on several past PN Hoffman projects. As stated earlier, PN Hoffman is a growing company building larger and larger buildings getting further away from large residential projects and into commercial driven approaches to design and construction. While using repeat workers is good for communication of what is needed from the subs, it is not as efficient when the projects become larger and larger.

The inefficiencies are more prevalent in the finishing trades because of the lack of experience with larger jobs. While the work required of the finishing trades are residential in nature, the scale of the work that is needed to be completed is not. A better method to managing activities might have helped to avoid overlapping of trades and help avoid work to be done twice or even skipped.

#### **Short Interval Production Schedule**

This approach in other projects by other companies is referred to as a SIPS or Short Interval Production Schedule. Experts say that in order to have a productive SIPS your project should have a minimum of 20 repetitive activity zones.

The Edgemoor has seven identical floors, 2 through 8. Each floor is then divided into 2 zones, East and West. The East and West zones are not identical but are similar in size and layout. Giving a total of 14 semi-repetitive activities I feel that it would not be

# THE EDMOOR CONDOMINIUMS

## BETHESDA, MARYLAND

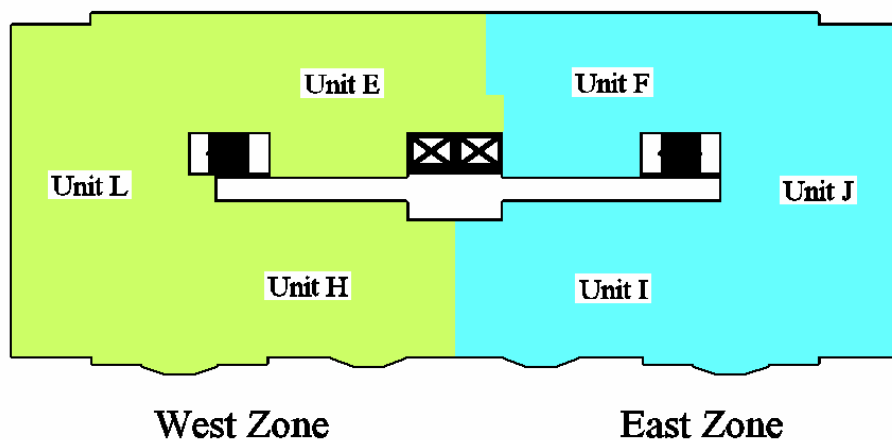
appropriate to call this approach a SIPS rather than to adapt some its key elements to The Edgemoor Condominiums such as a detailed Matrix Schedule and an Activity Train.

### Identifying Work Zones

The main purpose of separating the floors into two zones is to avoid multiple trades working in the same units at the same time. As depicted in the Activity Train in Appendix B when one activity moves from the East zone to the West zone the activity from the floor below will move up to the East Zone. See Appendix C for better Zone location detail.

For management purposes the zones in the Activity Train chart are labeled F1.1, F1.2, F2.1... #.1 will identify the East Zone and #.2 the West Zone. This is to avoid confusion with the unit numbers such unit 1E

*Figure 1 – Activity Zone Locations*



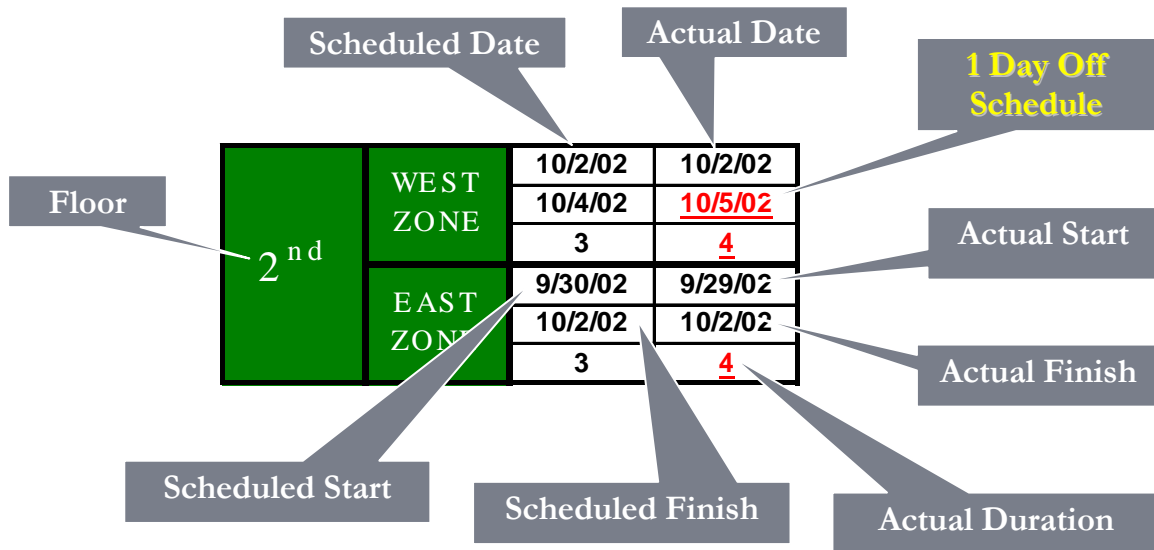


**THE EDGEMOOR CONDOMINIUMS**  
**BETHESDA, MARYLAND**

**Developing a Matrix Schedule**

The Matrix schedule has been developed in Microsoft Excel so that it can be easily updated by any competent person for the construction management team with a computer. Conditional Formatting was included in the actual start and finish dates and duration to display a late start in red font and underlined. This will allow the one who is updating the schedule to immediately identify a problem with a particular activity. The purpose for the underlining is to allow someone who does not have a color printer to convey the information at a foreman’s meeting or an on site job review.

*Figure 2 – Matrix Cell Identification*



Order of the Activity Columns follows the order of the activity train that is to be used in conjunction with the matrix schedule See Appendix B for the Activity train. The first floor also has 6 units just as the floors above but are smaller in area due to a lobby in the front entrance and a Party Room on the East side of the building. The Party Room is

## **THE EDGEMOOR CONDOMINIUMS**

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### **BETHESDA, MARYLAND**

not included in the schedule. The party room will be a separate contract and not affect the Activity Train of the individual units. Also the 9<sup>th</sup> and 10<sup>th</sup> floors are not typical floors and the three units one each of the two floors are very large and more customized than the lower floors. These units were treated as their own zones therefore you will have instead of two zones per floor you will have 3 zones on the 9<sup>th</sup> floor and 3 zones on the 10<sup>th</sup> floor.

#### **Developing an Activity Train**

I have made reference to an Activity Train Several time now in this report. Appendix B shows the Activity train for this particular project. Table 3 below shows some of 36 activities listed in the train and the subcontractors who have been contracted to do the work. Again, the focus here is on the finishing trades and how to better manage them to shorten the overall schedule; therefore the Activity Train begins at wall layout.

The train assumes 1 week per zone per activity. Given the number of zones and activities, all ten floors will be completed and ready for Owner Occupancy in 57 weeks. This is 2 weeks shorter than the actual schedule duration. The chart also assumes that a work week is 5 days long. The weekends will be used only if necessary to keep a particular activity from derailing. It is up to the management team have a strict policy on limiting overtime work to ensure that this weekend buffer is maintained and only used when absolutely necessary.

**THE EDGEMOOR CONDOMINIUMS**  
**BETHESDA, MARYLAND**

*Table 3 – Subcontractor Activities*

<b>INTERIOR ACTIVITIES</b>	<b>SUB-CONTRACTOR</b>
Sprinkler Piping and Heads	Simplex Grinnel
Plumbing Rough-In	Mallick Plumbing and Heating
Mechanical Rough-In	
Gas Rough-In	
Ductwork	
Plumbing Fixtures	
Electical Rough-In	Spartan Electric
Fire Alarm System Devices	
Lighting Fixtures	
Layout	DiGregorio and Sons
Wall Framing	
Insulation and Vapor barrier	
Hang Sheetrock	
Drywall Finish and Point-up	
Exposed Concrete Ceiling Finish	
Doors and Frames	Custom Hardware Inc.
Door hardware	
Flat Base Board and Trim	K & M Builders
Kitchen and Bathroom Cabinetry	Salix Cabinetry
Interior Prime, Paint, and Point	NLP
Cooridor Paint	
Bamboo, Oak, and VCT Flooring	CB Flooring
Cooridor Carpeting	
Ceramic Tile and Marble	David Allen Company
Cooridor Wood Trim and Kitchen Crown Molding	IBS
Granite Countertops and Marble Fire Place Surrounds	Sky Marble
Appliances	General Electric

## **THE EDMOOR CONDOMINIUMS**

---

### **BETHESDA, MARYLAND**

#### **Crew Sizes**

Crew sizes and durations are important to help maintain the activity train. The matrix projects a duration of 57 weeks, that's 2 weeks shorter than the actual jumbled time-scale bar chart. In order to stay on schedule, subcontractors will have two weeks to completely finish an activity on one floor or one week per zone. This might hard for some contractors to accomplish.

The mechanical contractor Mallick Plumbing and Heating usually runs with around 8 plumbers and mechanics and laborers. Since the Mechanical contractor has the most activities in the Train, they will probably be forced to use an additional crew of 3 to 5 men to pick up the slack. On the other hand DiGregorio, the drywall contractor, may be forced limit his crew size to avoid getting to far ahead. They are limited by close in inspections. Getting out ahead during layout and wall framing will create a long period of no work going on causing Digregorio management to pull those guys off the job and send them somewhere else, but it's is not likely that everyone pulled off will be sent to another site.

Updating the matrix schedule weekly and conveying that information at the Foremen's meeting will help subs deal with manpower and pace of work. The Biggest advantage in using a Matrix schedule will be the ability to update and rapidly identify an activity that is off schedule whether it is due to a late start or running long in duration.

**THE EDMOOR CONDOMINIUMS**  
**BETHESDA, MARYLAND**

*Table 4 – Matrix schedule Finish Date Comparison*

		READY FOR CERTIFICATE OF OCCUPANCY		READY FOR OWNER OCCUPANCY		DIFFERENCE OF OCCUPANCY DATES IN DAYS
10 <sup>th</sup>	Unit Q	10/27/03		11/3/03	11/17/03	14
		10/31/03		-	-	
	5					
	Unit M	10/20/03		10/27/03	-	
		10/24/03		-	-	
5						
Unit K	10/13/03		10/20/03	-		
	10/17/03		-	-		
5						
9 <sup>th</sup>	Unit P	10/6/03		10/13/03	10/27/03	14
		10/10/03		-	-	
	5					
	Unit O	9/29/03		10/6/03	-	
		10/3/03		-	-	
5						
Unit N	9/22/03		9/29/03	-		
	9/26/03		-	-		
5						
8 <sup>th</sup>	WEST ZONE	9/15/03		9/22/03	10/9/03	17
		9/19/03		-	-	
	5					
	EAST ZONE	9/8/03		9/15/03	-	
		9/12/03		-	-	
5						
7 <sup>th</sup>	WEST ZONE	9/1/03		9/8/03	10/2/03	24
		9/5/03		-	-	
	5					
	EAST ZONE	8/25/03		9/1/03	-	
		8/29/03		-	-	
5						
6 <sup>th</sup>	WEST ZONE	8/18/03		8/25/03	9/25/03	31
		8/22/03		-	-	
	5					
	EAST ZONE	8/11/03		8/18/03	-	
		8/15/03		-	-	
5						
5 <sup>th</sup>	WEST ZONE	8/4/03		8/11/03	9/18/03	38
		8/8/03		-	-	
	5					
	EAST ZONE	7/28/03		8/4/03	-	
		8/1/03		-	-	
5						
4 <sup>th</sup>	WEST ZONE	7/21/03		7/28/03	9/11/03	45
		7/25/03		-	-	
	5					
	EAST ZONE	7/14/03		7/21/03	-	
		7/18/03		-	-	
5						
3 <sup>rd</sup>	WEST ZONE	7/7/03		7/14/03	9/4/03	52
		7/11/03		-	-	
	5					
	EAST ZONE	6/30/03		7/7/03	-	
		7/4/03		-	-	
5						
2 <sup>nd</sup>	WEST ZONE	6/23/03		6/30/03	8/27/03	58
		6/27/03		-	-	
	5					
	EAST ZONE	6/16/03		6/23/03	-	
		6/20/03		-	-	
5						
1 <sup>st</sup>	WEST ZONE	6/9/03		6/16/03	8/20/03	65
		6/13/03		-	-	
	5					
	EAST ZONE	6/2/03		6/9/03	-	
		6/6/03		-	-	
5						

## **THE EDMOOR CONDOMINIUMS**

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### **BETHESDA, MARYLAND**

#### **Improved Cash Flow at the End of the Job**

Following a matrix schedule spreads out the work for each activity into identical durations. Comparing the actual finish dates of the lower floors to the dates projected from the matrix schedule show a large improvement in completion dates. As units are turned over to owners the transactions and final payment to PH Hoffman are finalized and processed.

Like most jobs cash flow late in the project is sometimes hard to come by. Matrix scheduling greatly improves cash flow to help pay subcontractors final payments, retainers, and outstanding change orders. No contractor wants a job to be halted a few weeks from completion due to a missed payment or two to subcontractors.

#### **Conclusion**

Durations given to activities are relative to the actual durations in time-scaled bar chart. Some activities were not as efficient as others for example some units underwent multiple point-ups by both the painter and drywall contractor. A unit would have just been final painted and a drywall worker would point up his work over the painter not knowing the paint was a final coat. The opposite is also true; the painting crew at times might accidentally point-up a unit that has not been pointed by the drywall contractor.

Adopting the Matrix Schedule method will greatly improve worker and trade efficiency. Below in Figure 3 is a portion of the matrix schedule for the Edgemoor Condominiums. It shows and compares the dates that particular zones are ready for Owner occupancy or tenant move in.

The duration improvements developed through the Matrix Schedule is two week for all units. The overall completion of units is actually better than two weeks. The lower floor is finished much earlier in the schedule than previously planned. This Schedule

## **THE EDMOOR CONDOMINIUMS**

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### **BETHESDA, MARYLAND**

meets an early summer goal set by the owners of PN Hoffman of having substantial completion of the first four floors and ready for owner occupancy by August 4, 2003. The schedule actually shows that this goal is met by July 28, 2003, one full week before the goal.

### **MEP Coordination**

MEP Coordination is a must for almost all commercial and large scale residential buildings. 3D CAD is great way to conduct MEP Coordination to avoid and identify problem areas on a particular project. Many mechanical contractors already use 3D CAD and have done so very efficiently.

There are several areas that 3D CAD is widely used in. In the pre-construction phase of a project modeling software is used for marketing, estimating, shop drawings, and assembly drawings. During the construction phase 3D Cad is used to develop schedules and create and manage coordination drawings.

### **Limited Bulkhead Space**

The Edgemoor uses Post-Tensioned slab to promote an open floor plan. The tenants prefer this design and can get pretty picky when that open space is diminished by bulkheads and drop ceilings therefore drop ceiling were all but eliminated and confining MEP systems to tight bulkheads and hallways with very shallow drop ceilings. The unit bulkheads needed to house HVAC ductwork, plumbing, Recessed lights and a Sprinkler system.

**THE EDGEMOOR CONDOMINIUMS**  
**BETHESDA, MARYLAND**

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*Figure 3 ~ 3D Model Representation of HVAC Ductwork.*

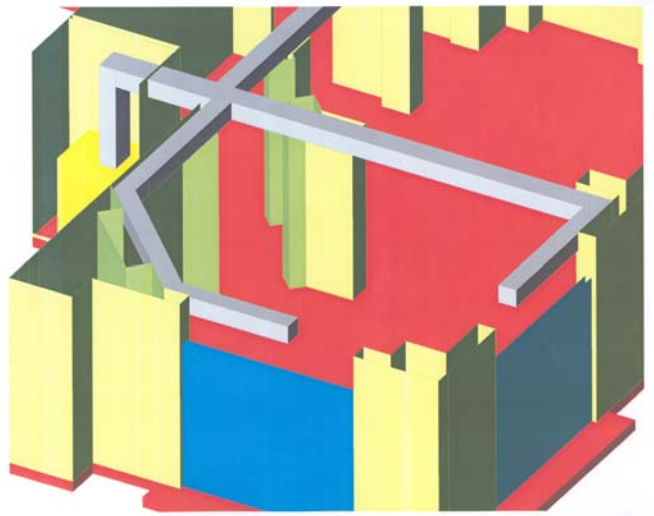
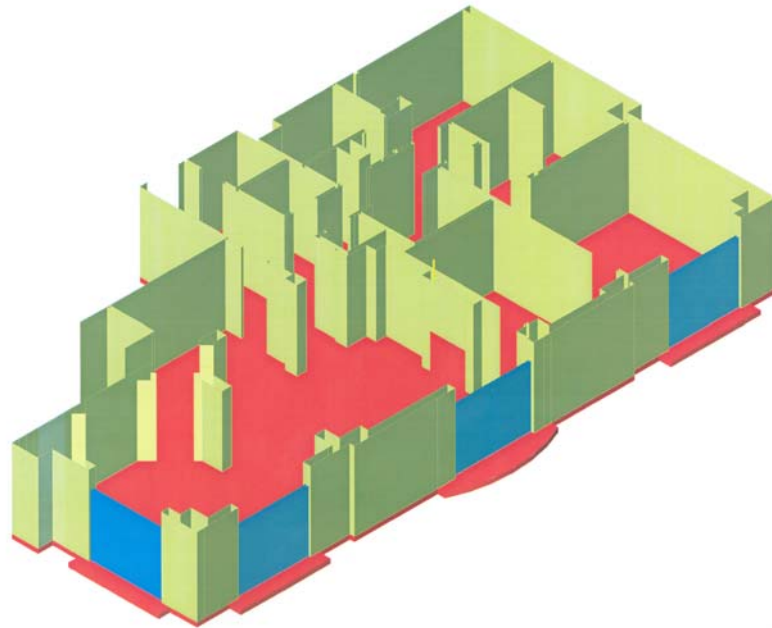


Figure 3 shows how the exposed ceiling finish in rooms like the dining room and family room cause the indirect routing of duct work around the room exterior. Notice that in order to wash the balcony doors colored in blue the ductwork must hug the walls of the room.



**Design Coordination Through 3D Modeling**

*Figure 4 ~ 3D Model of Typical J-Unit (eastern most unit)*



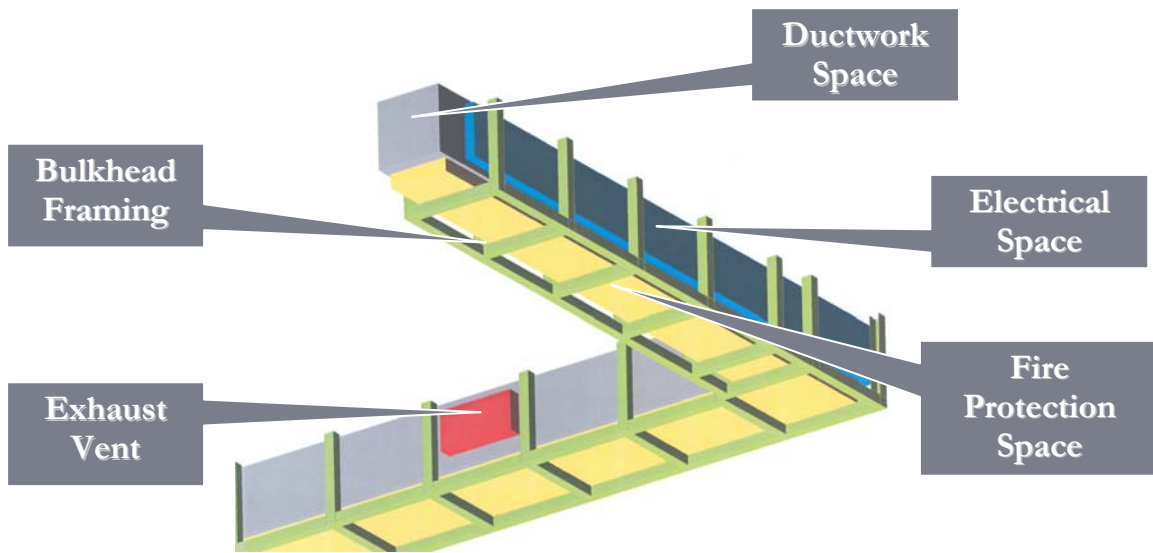
It is necessary to get all parties involved in 3D CAD coordination including the foreman from all parties since they will need to translate the model to their workers. Unfortunately, for the Edgemoor there was very little MEP coordination before construction of the systems began. The project adopted a first come first serve process, meaning that which ever subcontractor showed up first got to claim their space for their system and anyone else who came later would have to build around that first system. This approach seemed to work in some areas due to good management and communication between management and the Subs.

Using 3D CAD will help subcontractors better understand the design of their own system and more importantly understand the design of the other mechanical trades that might affect their design.

**Identifying Design Flaws with 3D CAD**

Below (figure 5) is a 3D model of a typical bulkhead. It helps to illustrate the specific locations that each mechanical trade owns. HVAC duct hugging the face for easy vent placement, Electrical located in the back of the bulkhead to allow for easy transition from a vertical wall to the bulkhead, and finally the fire protection system is located at the bottom of the bulkhead to allow for simple design of pendent style sprinkler heads.

*Figure 5 ~ 3D Model of Mechanical Trade Locations*

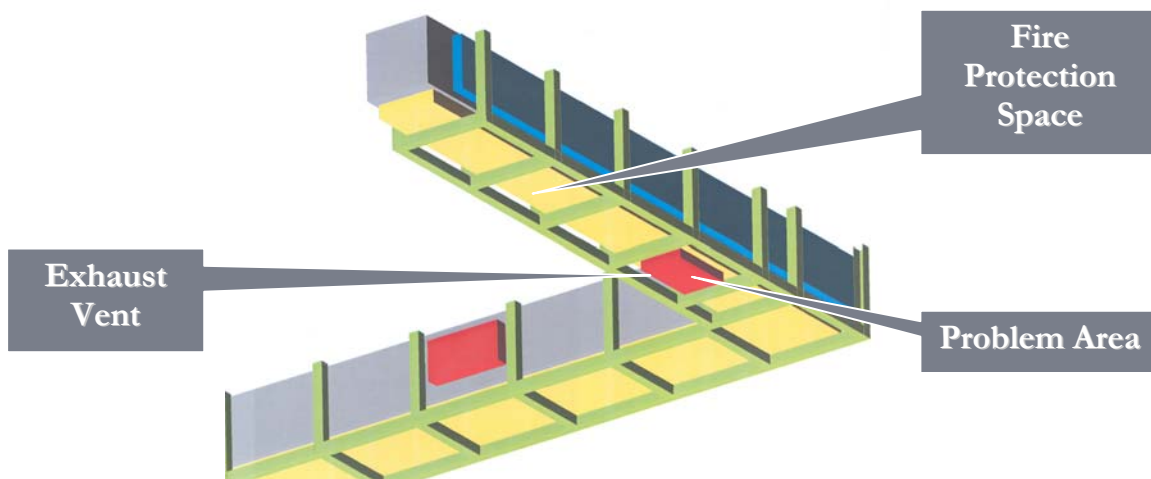


## THE EDGEMOOR CONDOMINIUMS BETHESDA, MARYLAND

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Figure 6 shows how 3D CAD can go beyond identifying trade locations. The placement of the second vent needs to be located on the underside of the bulkhead. It is quite obvious that the vent will have to enter the fire protection contractor's space. Coordination between the HVAC contractor and the fire protection contractor can now begin and create a solution to the problem and avoid a costly and time consuming on-site redesign.

*Figure 6 ~ 3D Model Showing Vent Location Coordination Conflict.*



## **THE EDGEMOOR CONDOMINIUMS**

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### **BETHESDA, MARYLAND**

#### **Conclusion**

3D CAD will greatly improve on-site MEP trade efficiency by avoid design conflicts proving that a first come first serve approach, while might have worked on smaller projects, will become increasingly less reliable as buildings become larger and larger. It will also help foremen better convey the overall design of the system to their mechanics and laborers. The more eyes you have looking at 3D MEP drawings, the more you can trust that the MEP contractors on the job site are on the same page.

**Structural Floor Slab Redesign**

**Existing Conditions**

The Edgemoor Condominium's floor slab is a post-tensioned system supported with cast-in-place columns. The Post-tension system begins with the second floor slab and continues to the roof slab for a total of ten post-tensioned slabs. The first floor and the three below-grade garage levels are all cast-in-place concrete.

The post-tensioned system is a 7" slab with an average span of 23 ft. The slab was designed to carry a total live load of 60 psf. Total cost for the system at \$370 per cubic yard is \$1,283,000. This system was chosen to promote an open floor plan and allow for partition wall inside each unit to be placed at any location. There are also no beams or girders in a post-tensioned system to complicate mechanical design or take away from the architectural integrity of the interior space.

**Hollow Core Plank System**

The system suggested to replace the post-tensioned slab is the use of hollow core planks. Assuming an average clear span of 23 for the planks and an allowable live load of 60 psf a plank size was chosen. (see Appendix D). The planks used will be a 4 foot wide by 8" thick hollow core plank followed with a 2" top coat of concrete. The design live load of these planks is 98 psf which is 18 psf over the required 60 psf.

**Advantages**

One advantage of using the system is it eliminates the tremendous amount of formwork necessary for a conventional slab design. Since there is no form work for the planks, trades can enter the floor below immediately after the planks have been set in

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### **BETHESDA, MARYLAND**

place. This will then help trade start dates to be moved up in the schedule to alleviate congestion at start of the finishing trade Matrix schedule

Another advantage is with the 2" topping slab. Near 90 % of the owners have selected Bamboo flooring in their units. The flooring used is an engineered bamboo laminate. The deflection tolerances for this engineered bamboo are much less than one can expect to find with a 7" post-tension slab spanning 22+ feet. Some of the slabs needed to have high spots ground down or low spots filled to meet the bamboo tolerance specifications. Assessing a high tolerance to the 2" top coat can help ensure the flooring contractor that they will have a near perfectly flat surface to lay their floor on.

#### **Disadvantages**

Unlike the post-tension which uses a web of stressed cables to transfer load to columns, hollow core plank need to be placed on girders for support. These interior girders are what the architect wanted to avoid their design. These girders will need to be closely studied by the MEP contractors. They will now have to adjust their designs to go around the girders.

Another disadvantage is the increase in building height by going to a thicker slab system. The post-tension slab is only 7" thick. The Hollow Core system is 8" thick plus a 2" top coat for a total of 10". This 3" difference over 10 floors will increase the building overall height by 2.5 feet. The only concern here is cost, the Edgemoor is nowhere near height restrictions in downtown Bethesda and a 2.5 foot increase would be insignificant in the eyes of Bethesda City Planners.

#### **Plank and Girder Layout**

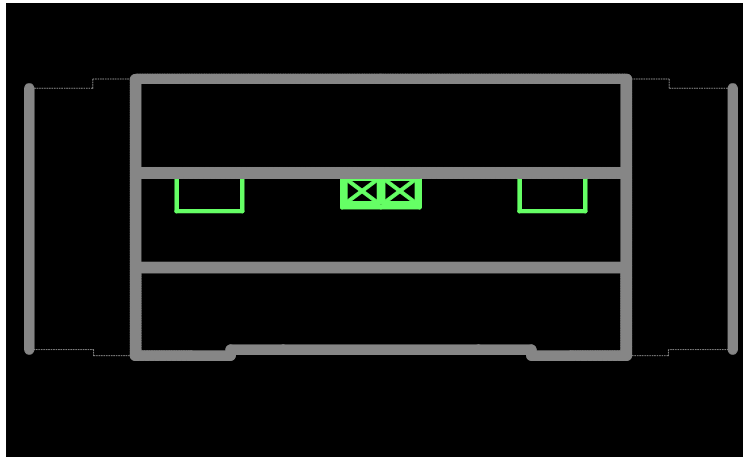
To maintain the integrity of an open floor plan design the planks on the East and West sides of the building have been turned 90 degrees to eliminate girders in those

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units.(see figures 7 & 8) Also, the layout falls on the existing column locations continuing the theme of preserving the architectural integrity.

*Figure 7 ~ Girder Layout*



Average clear span for the girders is 20 feet and total approximately 5,200 linear feet. Again, because the girders fall on the existing column placements, the girders themselves fall in line with most demising walls maintaining the architectural integrity of the individual units.

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**BETHESDA, MARYLAND**

*Figure 8 ~ Hollow Core Plank Layout*

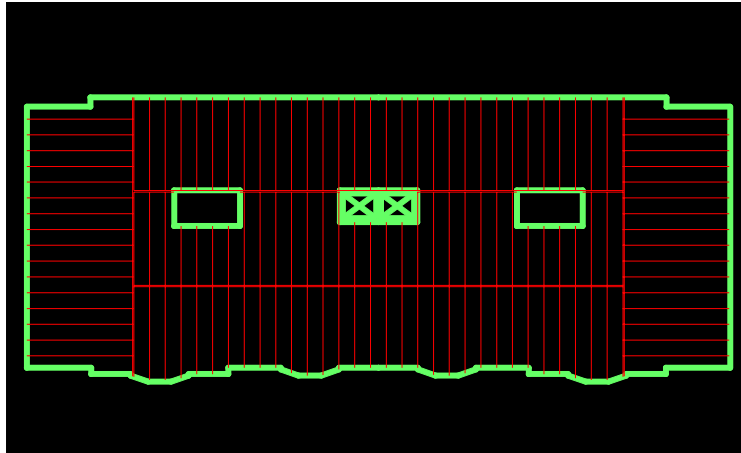


Figure 8 shows the hollow core plank layout for a typical floor. The building would contain 127 planks per floor per 10 floors giving a total of 1,270 planks for the building.

**Member Sizes**

Width & Depth

Avg. Clear Span = 20'

$M_u = 69\text{K-Ft}$

$$d^2 = (R \cdot M_u)/b \rightarrow (d^2 = (30 \cdot 71\text{K-Ft})/8'')$$

$b = 8'' \quad d = 16''$  (see figure 5)

Bar Sizes

$$A_s = (M_u + M_{u_{sw}})/4d \rightarrow (78.3\text{K-Ft})/(4 \cdot 16'') = 1.45 \text{ in}^2$$

$$2 \text{ #8 Bars} = 1.58 \text{ in}^2$$

$$M_n = (1.58 \text{ in}^2)(60\text{ksi})(13.5 - (1.74/2)) = 99.8\text{K-Ft}$$

$$99.8\text{K-Ft} > 78.3\text{K-Ft} \rightarrow \text{O.K.}$$



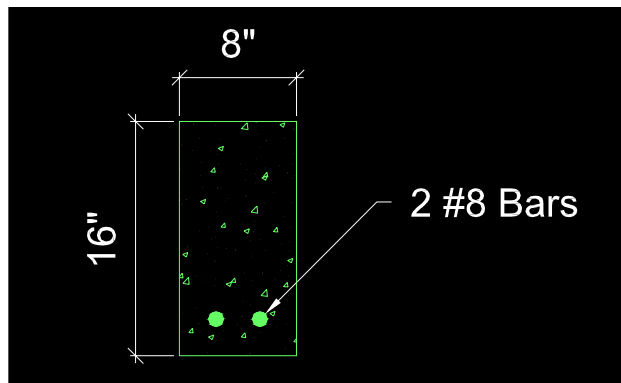
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**BETHESDA, MARYLAND**

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The Typical member sizes were determined using the simplified beam equation. The average width and depth is equal to an industry standard for concrete beam design estimates. (see figure 9 for typ. girder dimensions)

$$\begin{aligned} \text{Depth} &= 1/15 \text{ the clear span} \\ \text{Width} &= 1/2 \text{ the depth} \\ 20 \text{ ft} / 15 &= 16'' \\ 17.5'' / 2 &= 8'' \end{aligned}$$

*Figure 9 ~ Typical Building Girder*



The average estimated depth of the girder was determined to be 16". This dimension will have minimal impact on door and window locations due to every floor having a 9 foot finish ceiling height.

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### **BETHESDA, MARYLAND**

#### **Cost Savings**

##### Post Tensioned System

3,470 CY

Unit Price = \$370 per CY

Total Cost = \$1,283,000

##### Hollow Core System Estimate

115,000 SQFT

Unit Price of Planks = \$4.71 per SQFT = \$541,000

Pre-Cast Girders = \$126 per LNFT = \$655,000

Total Cost = \$1,196,000

The overall construction cost savings by switching to a hollow core plank system totals \$87,000

#### **Conclusion**

Using a Hollow Core Plank System instead of the existing post-tensioned slab system will save construction cost of \$87K. This system will also allow trades to move up their start dates due to lack of formwork activities that you would normally have with conventional concrete slab construction.

This system may not be very appealing to MEP contractor who must now take extra time and use more materials to traverse around the girders which will more than likely conflict with their design. This added obstacle will most definitely show up in the contractors initial bid which will intern not make the owners all to enthusiastic of using such a system.

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**Appendix A ~ Theoretical Matrix Schedule**

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**Appendix B ~ Edgemoor SIPS Activity Train**

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**Appendix C ~ Typical Floor Plan with Zone Locations**

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**Appendix D ~ Hollow Core Plank Spec Sheet**

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Specification Sheet for 8" Spandek Hollow Core Plank  
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