Pentagon – Wedge 3
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Construction Management

Technical Assignment 1

Contents

Executive Summary

The largest renovation construction project in history is located along the Potomac River, just across from the nation's capital, at the center for the Department of Defense for the United States. The Pentagon Wedges 2 through 5 project is a $2 billion contract, projected for finish in 2010. The wedge currently under construction is Wedge 3, with a lump sum contract value of $367,000, which it is not surprising considering that it is approximately a one million square foot section of this massive building.

This project is a LEED certified building under the LEED Existing Buildings criterion. It shows great efficiency in its design because of the Universal Space Plan, or USP. The USP integrates natural daylight, flexible office space and an efficient overhead mechanical system to help achieve this certification. Great attention is paid to tracking the LEED points by a team of sustainability coordinators.

Trying to compare this project to others in magnitude is a difficult task, as is demonstrated in the Project Cost Evaluation section. A cost estimate based on historic data from the D4 cost estimating program and also from R.S. Means square foot cost data showed large deviations from the actual costs of Wedge 3.

Scheduling is quite unique to this project as well. Wedge 3 is divided into two phases, each of which have three sub sections, as well as five floors. Phase one includes sub-areas ten, thirteen, and fourteen. Interesting scheduling technique utilizing these zones ensures the flow of work is constant and uninterrupted. A schematic summary prepared in the computer program Primavera illustrates the milestones and major steps of the construction process.

The following document contains information about the building itself, as well as the complexities of the project because of the local conditions and project expectations. The government organization acting as the owner for the renovation is called PenRen, for the Pentagon Renovation, and their expectations and goals are discussed in great detail. The general contractor, Hensel Phelps will also be reviewed. They have a large staff involved in the project, and have implemented several interesting scheduling and management techniques to provide PenRen with a finished product that is ….

On Cost

On Schedule

Built for the next 50 years

Building Systems Summary

Demolition

Wedge 3 of the Pentagon Renovation project has an atypical scope of work. The demolition process includes the removal of all utilities; mechanical, plumbing, electrical, data, fire fighting. The scope also includes all interior walls being removed, floors stripped to the existing concrete slabs, and all windows taken out. There are several dangerous materials found in Wedge 3 that require proper removal techniques. There are millions of pounds of asbestos containing materials, lead paints, and PCB's in several older ballasts.

Figure 1 - A bobcat removes trash in Wedge 3 demolition area.

During the peak of demolition, there may be up to three hundred employees working. Most utilities are torn down with this man power, and bobcats handle tearing down of many of the walls and larger objects. Non hazardous materials are either carted by hand, or pushed by the bobcats, and taken to a large trash shute found near the high side of corridor seven, just at Wedge 3. The trash then falls to a dumpster below and is shipped off sight. Much of the recyclable material is separated beforehand and carted to their respective dumpsters for proper collection.

The abatement process is much more involved than normal waste removal. These zones are contained with plastic, and workers wear protective clothing and breathing apparatuses to prevent inhalation of hazardous materials. Leads and PCB's are contained in large steel barrels and sealed.

Fig. 2 – Trash chute in demolition area.

Concrete Structure

The Pentagon was poured built in 1942, and is structurally composed of cast in place concrete. The slabs are one way, with composite beams. Structurally the slabs carry a load. .

The work was done hastily, formed with plywood with rebar set inside. Little was done to prevent aggregate from falling only to the bottom, as modern vibration techniques were not practiced. Also, to shave time off the demanding schedule of pouring the structure, conduit was run directly through many of the columns, beams and slabs before the pours.

These factors cause great inconsistencies which must be addressed in Wedge 3. There are several places where the concrete has "honeycombed", or deteriorated, leaving rebar dangerously exposed. Some of these locations require structural patching. Several of the columns with old conduit will be patched, since several of these runs travel between areas that must be separated by fireproofing materials.

Furthermore, during the original concrete pour, a commonly used insulation was laid in the forms prior to the pour. This insulation is flammable, and will be removed and replaced with modern insulation.

Mechanical System

The main mechanical supply for Wedge 3 is not located there, and information regarding it's location and capacity may not be discussed at this time. However, the system is very simple and generic at the distribution level. Chilled or hot water treats the air, and round duct delivers it through large bulkheads running down the center of each of the five rings. There are no return ducts, simply induction units which remove air into overhead plenum space, where it becomes part of a recycled air supply. There are several mechanical closets located along the main corridors, which contain local distribution and zonal controls.

Electrical System

The main electrical supply for Wedge 3 is not located there, and information regarding its location and capacity may not be discussed at this time. However, the design depicts several electrical closets located on each floor along the some of the five rings. Power comes from the main power supply into these closets at 480 volts, and is distributed from there. Four inch conduit runs overhead with these wires. Telecommunications closets are located on each floor, and deliver communication and send data throughout Wedge 3. Security systems run from this as well. Low voltage power lines run overhead in cable tray with some of these wires.

Figure 3 – A telecommunication closet from Wedge 2, which looks similar to the design for Wedge 3.

Masonry

The existing exterior walls of the outer E-ring and the inner A-ring, visible from the outside of the Pentagon and from the center courtyard, respectively, are limestone masonry with matching mortar. Some stones will be repaired, and others replaced. An issue from Wedge 2 that will carry over to Wedge 3 is the delicate process of matching the color of the mortar perfectly to the existing. A large area where the limestone has been removed is at the location of the trash chute, and several onsite color matching tests will be performed by Masonry Arts until the PenRen quality inspectors approve a match.

Figure 4 - An example of poorly matched limestone patching on an historic mall entrance column.

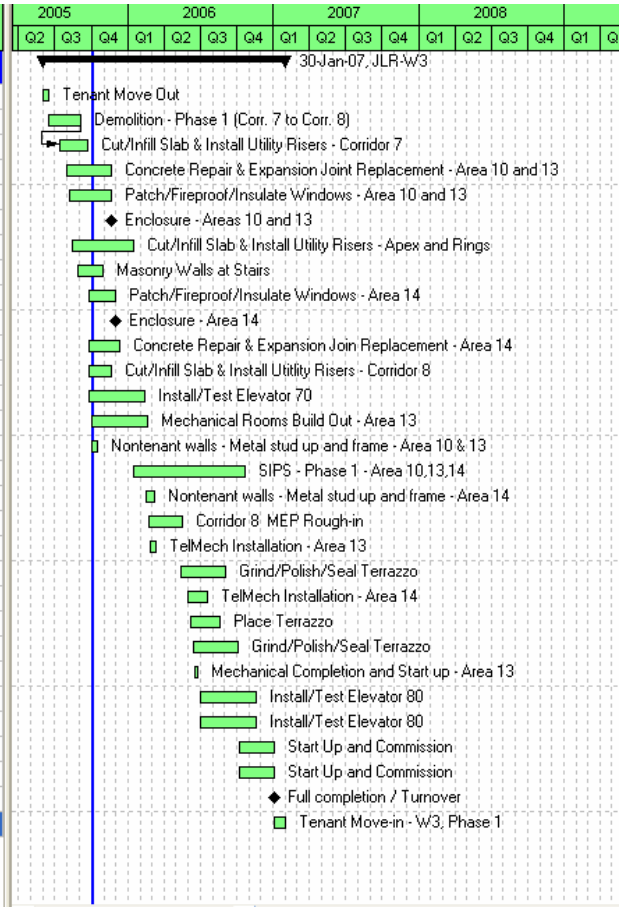
In addition to the masonry walls, there will also be repairs done on the existing limestone columns of the mall terrace entrance. Once again, the mixing must be done carefully, with a balance of sands, cement mix and water.

Project Schedule Summary

This Schedule Summary applies only to the first phase of Wedge 3 construction, which covers the area from corridor 7 to corridor 8 of the Pentagon. Phase 2 has not yet been scheduled by the general contractor. Completed in Primavera Project Manager, this schedule shows the flow of work, with tenants moving out of the existing space preceding all construction activities. The commencement of demolition is the first construction step, then structural and concrete repairs are performed, slabs are filled with concrete, and new utility penetrations will be cut. During this time, masonry walls are being set around existing stairwells and elevator shafts which did not exist previously are installed.

The large time designated to SIPS for Areas 10, 13 and 14 refer to the tenant fit out for all interior spaces, which includes the installation of sprinkler lines, duct, induction units, conduit and wires, drywall, ceiling grid and tile, doors, blinds, and more. A much more detailed schedule is necessary to show each of these steps in detail.

Activity ID	Activity Name	Original Duration	Start	Finish
JLR-W3		422	01-Jun-05	30-Jan-07
A1000	Tenant Move Out	11	01-Jun-05	15-Jun-05
A1010	Demolition - Phase 1 (Corr. 7 to Corr. 8)	57	15-Jun-05	02-Sep-05
A1020	Cut/Infill Slab & Install Utility Risers - Corridor 7	48	15-Jul-05	21-Sep-05
A1022	Concrete Repair & Expansion Joint Replacement - Area 10 and 13	79	01-Aug-05	18-Nov-05
A1023	Patch/Fireproof/Insulate Windows - Area 10 and 13	74	08-Aug-05	18-Nov-05
A1024	Enclosure - Areas 10 and 13	0		18-Nov-05
A1025	Cut/Infill Slab & Install Utility Risers - Apex and Rings	105	15-Aug-05	13-Jan-06
A1031	Masonry Walls at Stairs	44	29-Aug-05	28-Oct-05
A1041	Patch/Fireproof/Insulate Windows - Area 14	46	26-Sep-05	30-Nov-05
A1042	Enclosure - Area 14	0		30-Nov-05
A1051	Concrete Repair & Expansion Join Replacement - Area 14	53	26-Sep-05	09-Dec-05
A1061	Cut/Infill Slab & Install Utitlity Risers - Corridor 8	40	26-Sep-05	18-Nov-05
A1071	Install/Test Elevator 70	96	26-Sep-05	10-Feb-06
A1081	Mechanical Rooms Build Out - Area 13	96	03-Oct-05	17-Feb-06
A1091	Nontenant walls - Metal stud up and frame - Area 10 & 13	10	03-Oct-05	14-Oct-05
A1101	SIPS - Phase 1 - Area 10,13,14	197	16-Jan-06	20-Oct-06
A1210	Nontenant walls - Metal stud up and frame - Area 14	15	17-Feb-06	09-Mar-06
A1220	Corridor 8 MEP Rough-in	60	24-Feb-06	18-May-06
A1231	TelMech Installation - Area 13	11	27-Feb-06	13-Mar-06
A1241	Grind/Polish/Seal Terrazzo	78	15-May-06*	01-Sep-06
A1251	TelMech Installation - Area 14	34	02-Jun-06	20-Jul-06
A1261	Place Terrazzo	53	07-Jun-06*	21-Aug-06
A1271	Grind/Polish/Seal Terrazzo	78	15-Jun-06*	04-Oct-06
A1281	Mechanical Completion and Start up - Area 13	5	19-Jun-06	23-Jun-06
A1291	Install/Test Elevator 80	98	03-Jul-06*	17-Nov-06
A1300	Install/Test Elevator 80	98	03-Jul-06*	17-Nov-06
A1310	Start Up and Commission	58	09-Oct-06	02-Jan-07
A1320	Start Up and Commission	58	09-Oct-06	02-Jan-07
A1330	Full completion / Turnover	0		02-Jan-07
A1340	Tenant Move-in - W3, Phase 1	20	03-Jan-07	30-Jan-07



Project Cost Evaluation

Actual building construction and demolition cost =	$300,000
Construction and demolition cost per square foot =	$300 / sf
Total project costs =	$367,000,000
Total project costs per square foot =	$367 / sf
Major Building Systems cost =	N/A
Major Building Systems cost per square foot =	N/A

D4 Cost Estimate

Using the D4 program to estimate the cost of this particular construction project proved to be challenging, because the Pentagon is a very unique building. There truly exists no building quite similar to it, and therefore it is difficult to find a low rise office renovation of such a large square footage. The closest building in the D4 history was the Los Angeles Public Library Center, which has the following statistics:

- Building Size: 537,903
- Building Cost: $217 million

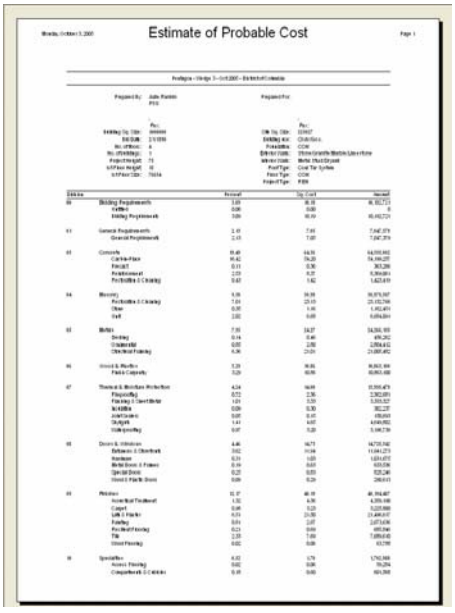


Fig. 5 – Example of the D4 cost estimate, shown larger below.

Estimate of Probable Cost

Building - Pentagon - Oct 2005 - District of Columbia

Building Sq. Size : 1000000
Bid Date : 1/1/2002
Project Height : 79
1st Floor Size :
1st Floor Height : 15
No. Of Buildings : 1
No. Of Floors : 5
Project Type : REN
Building Use : Civic/Gov.
Exterior Walls : CON
Interior Walls : CON
Foundation : CON
Roof Type : Tar
Floor Type : Terrazzo

Building Costs

Code	Division Name	%	Sq.	Cost	Projected
00	Bidding Requirements		3.09	10.19	10,192,721
	Bidding Requirements		3.09	10.19	10,192,721
01	General Requirements		2.13	7.05	7,047,379
	General Requirements		2.13	7.05	7,047,379
03	Concrete		19.49	64.36	64,355,002
	Cast-In-Place		16.42	54.20	54,199,257
	Precast		0.11	0.36	363,266
	Reinforcement		2.53	8.37	8,369,061
	Restoration & Cleaning		0.43	1.42	1,423,419
04	Masonry		9.38	30.98	30,979,307
	Restoration & Cleaning		7.01	23.13	23,132,766
	Stone		0.35	1.16	1,162,451
	Unit		2.02	6.68	6,684,091
05	Metals		7.35	24.27	24,266,155
	Decking		0.14	0.46	456,262
	Ornamental		0.85	2.80	2,804,412
	Structural Framing		6.36	21.01	21,005,482
06	Wood & Plastics		3.29	10.86	10,863,100
	Finish Carpentry		3.29	10.86	10,863,100
07	Thermal & Moisture Protection		4.24	14.00	13,995,479
	Fireproofing		0.72	2.36	2,362,681
	Flashing & Sheet Metal		1.01	3.33	3,333,327
	Insulation		0.09	0.30	302,237
	Joint Sealers		0.05	0.15	150,693
	Skylights		1.41	4.65	4,649,802
	Waterproofing		0.97	3.20	3,196,739
08	Doors & Windows		4.46	14.73	14,725,342
	Entrances & Storefronts		3.62	11.94	11,941,273
	Hardware		0.31	1.03	1,031,675
	Metal Doors & Frames		0.19	0.63	633,536
	Special Doors		0.25	0.83	828,246
	Wood & Plastic Doors		0.09	0.29	290,613
09	Finishes		12.17	40.19	40,194,487
	Acoustical Treatment		1.32	4.36	4,359,190
	Carpet		0.98	3.23	3,225,800
	Lath & Plaster		6.51	21.50	21,496,617
	Painting		0.81	2.67	2,673,636
	Resilient Flooring		0.21	0.69	685,846
	Tile		2.33	7.69	7,689,610
	Wood Flooring		0.02	0.06	63,788
10	Specialties		0.52	1.70	1,702,988
	Access Flooring		0.02	0.06	59,284
	Compartments & Cubicles		0.18	0.60	601,568
	Identifying Devices		0.18	0.60	598,662
	Pedestrian Control Devices		0.03	0.09	87,184
	Visual Display Board		0.11	0.36	356,290
11	Equipment		5.53	18.25	18,252,216
	Audio-Visual		0.15	0.51	510,314

	Food Service	0.04	0.13	130,776
	Library	5.13	16.94	16,942,717
	Maintenance	0.20	0.67	668,409
12	Furnishings	2.18	7.19	7,192,399
	Furniture & Accessories	1.98	6.54	6,538,784
	Window Treatment	0.20	0.65	653,615
13	Special Construction	0.24	0.80	797,732
	Integrated Assemblies	0.08	0.25	252,833
	Sound, Vibration & Seismic Ctr	0.17	0.54	544,899
14	Conveying Systems	5.46	18.03	18,030,189
	Elevators	3.89	12.83	12,827,642
	Lifts	0.01	0.05	47,079
	Material Handling Systems	1.56	5.16	5,155,468
15	Mechanical	10.27	33.91	33,914,495
	Basic Materials & Methods	8.31	27.45	27,445,458
	Fire Protection	1.96	6.47	6,469,037
16	Electrical	10.19	33.64	33,638,413
	Basic Materials & Methods	10.19	33.64	33,638,413
	Total Building Costs	100.00	330.15	30,147,405

Site Costs

Code	Division Name	%	Sq. Cost	Projected
02	Site Work	100.00	29.08	6,486,056
	Demolition	20.74	6.03	1,345,232
	Earthwork	24.27	7.06	1,574,417
	Excavation Support Systems	10.52	3.06	682,031
	Gas Methane Venting System	25.47	7.41	1,652,317
	Improvements	1.44	0.42	93,711
	Landscaping	6.03	1.75	390,804
	Paving & Surfacing	1.81	0.53	117,570
	Preparation	9.71	2.82	629,975
	Total Site Costs	100.00	2908.19	6,486,056

Total Project Costs =	$ 336,633,461

Square Foot Estimate

- Use "Commercial/Industrial/Institutional - Office, 5-10 Story" of R.S. Means Square Foot Costs, 2005 edition.

Assumptions

- R.S. Means square footage estimating data does not included renovation type construction projects. Yet in an effort to complete a cost comparison, the following is a square foot estimate showing the cost for a newly built structure of the same size and magnitude of the Pentagon - Wedge 3.
- Book only reads to 300,000 square foot area, I will slightly decrease the square foot cost slightly.
- The first and second floors of the Pentagon do not have light wells between rings, while the third, fourth and fifth do. Assume these light wells do not count as perimeter walls, and simply use the Wedge 3 footprint as the perimeter, approximately 2,000 linear feet.

Cost Per Square Foot of Floor Area Adjustments

- Exterior wall – Limestone Panel/Concrete Block Back-up – Reinforced Concrete Frame – 300,000sf – 700 linear feet perimeter = 105.75 / sf
- Adjust for 1,000,000 sf from 300,000 sf = 100.00 / sf
- Adjusted Perimeter to 2,000 lf from 700 lf– add 1.30 per lf
- Adjusted Story Height from 12 ft to 15 ft – add .70 / ft

Calculations

$100 /sf * 1,000,000 sf = $10,000,000
$1.30 /lf * (2,000-700) lf = $1,690
$0.70 /ft * 3 * 1,000,000 sf = $2,100,000

Total square foot estimate for a NEW office building =	$102,101,690

Project Cost Conclusions

The various estimates are all lower than the actual project cost for Wedge 3. This is certainly because of the complexity of such a large demolition and rebuilding process. The coordination and management alone requires about one hundred full time employees, as well as several hundred craftsmen. Also, there are systems in the Pentagon which are unique and more costly than may be found in lower security office complexes.

The square foot estimate is extremely low, which should be accredited to the lack of similar projects from which to choose. The D4 estimate was much closer to the actual cost. At about %8.3 under the actual cost, this estimate was the most successful of the general estimates. A more detailed assemblies estimate should provide an even closer estimate of the actual cost.

Local Conditions

The Washington D.C. and immediate metro area share a unique condition that is reflected in the appearance of the city, as well as having a substantial effect on the methods of construction commonly used in the region. This condition is a severe height restriction, which has been in place since 1910, when the federal government passed the act. In a time when ever-growing sky scrapers were shooting up in American cities all over the country, this act ensured that the race for the tallest skyscraper would not occur in Washington, overshadowing the monuments.

This height-restriction has affected the way construction occurs at the nation's capital for nearly one hundred years. In an effort to decrease wasted plenum space, it is very common for buildings in the Washington D.C. area to be structural concrete buildings, which helps to maximize the floors capable of fitting into the height restriction. However, a major factor affecting the structure of the Pentagon deals with the time of its construction. It was built during World War II, and in an effort to not exhaust the supply of metals needed for war machines, the structure was designed as fully cast in place poured concrete. The only structural steel found in the Pentagon is reinforcement in the original concrete, and now in the renovated area, there are steel reinforcing beams to support some cut penetrations.

The Pentagon Reservation is a massive plot of land along the Potomac River, directly across from Washington. The reservation is an astounding 296 government owned and usable acres, of which 29 acres are consumed by the actual structure, and with 67 acres of parking space. With such a vast area, there was ample space for lay down area, and on site parking. For Wedge 3, the existing Pentagon employee parking lot in front of wedge 3 and the mall terrace entrance has been closed and is off limits for their parking to serve construction trailers and lay down. Many of the daily construction employees and craftsmen park at the Pentagon's south parking lot across a pedestrian walkway, or at off site parking garages.

As this building renovation project strives for LEED certification, it naturally involves recycling in the construction process. Old materials are sorted and recycled after their demolition, and new materials for the rebuilding are recycled as well. The Pentagon reservation also is located near an alternative fuel station with higher efficiency fuel, which helps to, giving another credit to the building for LEED certification.

The land where the Pentagon was built was originally a swampy marshland on the banks of the Potomac River. Though drained, it is susceptible to soggy ground conditions. The foundation of the original concrete structure has settled, and the ground below it has compressed, unevenly at times, over the years under the immense weight of the building, but the structure is still sound.

Client Information

The owner of the project is a government program known as the Pentagon Renovation Program, commonly referred to as PenRen. Wedge 3 is only one part of a large renovation plan to rebuild the entire reservation, including not only the immediate structure, but also a new metro entrance, and a remote deliveries facility. PenRen was formed in out of necessity to have a team of people leading the renovation project.

This construction project is crucial because the building is now nearly sixty four years old, and many of its' major systems have yet to be updated. Tenants have repeatedly enclosed areas for personal office space, reducing efficiency for flow of the old air supply. Old pipes suffer from leaks, rust and corrosion. Asbestos materials were common in construction in the 1940's, and over 23 million pounds of asbestos material are found throughout the Pentagon, including floor and ceiling tiles and various insulation. PCB's were visible in the ballasts of lighting systems and lead paints still coat much of the space. In total, the building's systems were outdated, inefficient, hazardous, and ironically often times failing building codes. In recognition of this, PenRen initially developed guidelines and standards, for quality, cost and safety.

One of the prominent goals of PenRen was to achieve an economical, aesthetic, and most importantly uniform new look for the Pentagon. Another expectation was that the updates

would last for at least fifty years before another major renovation was necessary, prompting them to set the specifications in construction contracts for a fifty year design.

Cost

The major cost concern that PenRen had during the developmental stages of Wedges 2 through 5 was keeping the project on the predetermined budget. Wedge 3 is comprised mostly of office space, with repetitive systems and floor plans. Therefore, if a part of the design specified equipment of material that was less cost efficient than an alternative, the price is multiplied throughout the entire floor plan, making the costs for inefficiency substantial. To avoid this, the architect, general contractor and PenRen worked closely through the design process, creating mock ups in an attempt to alleviate issues during construction.

Quality

PenRen has established extremely high expectations for a quality product. To ensure that work is performed to the fifty year specification plan, the owner has implemented their own quality control team. This quality control team works closely with the general contractor's quality control team. They have developed a method of four phases of quality control. Daily inspections are a large part of this plan. Some of these inspections include the Initial, In-house, Pre-final, and Final. All items are listed and tracked through a system called Prolog, which ensures that punch list items are not overlooked.

Figure 1 – The quality control team performs a ceiling close-in inspection.

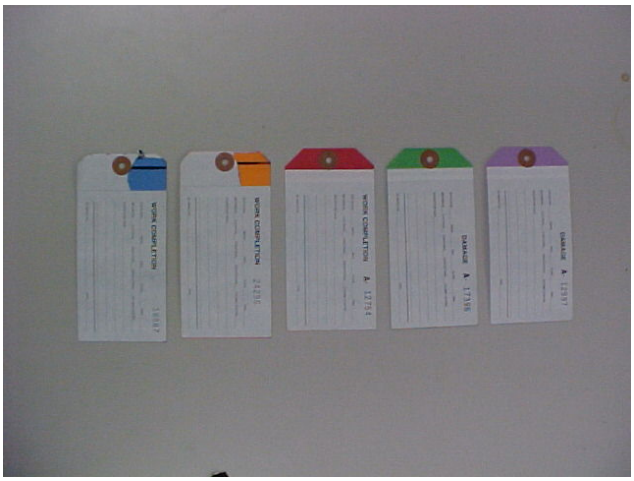


Figure 2 – The five color coded tracking tags

A system of tagging is used during inspections. The tags are color coded, so that various subcontractors recognize the tags hanging from objects and identify the color as their own to know if they are involved in addressing the issue. The color coding works as follows:

- Blue – Drywall / Carpentry
- Red – Mechanical
- Green – Electrical
- Orange – Caulk
- Purple – Other / Miscellaneous

All tagged items are entered into prolog by the QC administrators and `tracked daily by PenRen and Hensel Phelps inspectors.

Schedule

When dealing with a renovation project of such magnitude, schedule is inherently a critical issue. Wedge 3 is only one wedge of five at the Pentagon, and with each one having a size of approximately one million square feet, it was important to the owner that each wedge was completed quickly, or else the space would be losing a lot of potential office space, and hence efficiency of its operations.

Initially, the entire Pentagon Master Plan Renovation was projected to be complete in

2014, with the finishing of the fifth wedge. This placed Wedge 3 at a completion date of 2009 or 2010. However, combining some unique acceleration ideas and SIPS, or short interval production schedules, the general contractor was able to develop a fast track schedule that calls for completion of the fifth wedge by 2010, setting Wedge 3 for full completion in 2007. This is one of the reasons that PenRen chose Hensel Phelps as the major general contractor for Wedges 2 through 5. The first phase of Wedge 3 will turn over to the owner in January of 2007, while the second phase will be turned over in October of the same year.

Safety

The owner, in conjunction with the general contractors, has set an extremely high standard for safety on the construction site. A major concern is keeping civilians and military personnel away from construction. The solution is to fully isolate all construction areas. Only individuals with a proper construction badge may enter the site at any time, and under no circumstances may escorted visitors enter. Properly trained Pentagon Police officers patrol the site daily to enforce this regulation.

Another example of the safety standard is the barrier wall. A metal framed, fire rated wall must separate usable Pentagon space from the construction zone. All penetrations must be caulked and fireproofed, leaving no gaps. Metal doors are installed for fire escape purposes, but they have plentiful signage discouraging any non-construction traffic.

It is necessary for anyone who is given a construction badge to undergo a safety training seminar, lead by a safety expert from the general contractor, Hensel Phelps. The class is offered in both English and Spanish, and is an approximately four hour session reviewing

A final example of the safety precautions is the enforcement of PPE, or personal protective equipment. Any individual entering the site must wear three articles of PPE, which are hardhat, a brightly colored construction vest, and safety glasses. The hardhat must face forward, and the safety glasses must not be darkly shaded or worn over glasses unless they are the proper design for that purpose.

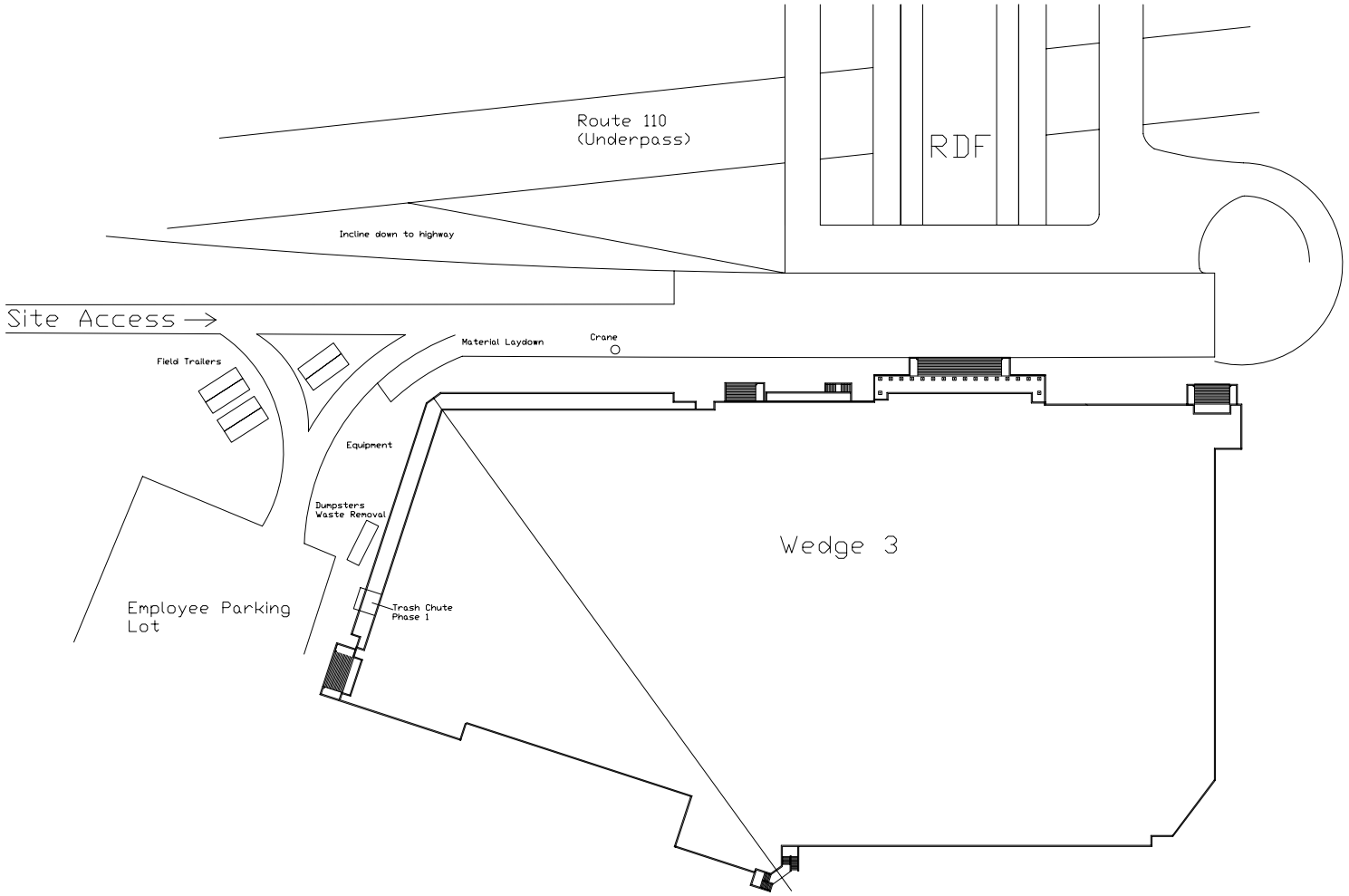
Occupancy

Over 23,000 people work at the Pentagon everyday, some military and others civilians and civil servants. While this is not considered any where near the full capacity of the building, it is still a major concern of the owner that daily operations not be disturbed or productivity decreased as a result of the construction. Though tenants must be relocated during renovation, PenRen desires that the tenants are accommodated. Tenants are notified months ahead of time as to the date that they will need to move their offices.

It is also important to the owner that each division of the military operating inside the Pentagon has the opportunity to be involved in the design phase of their new area. Involvement in the tenant fit out process ensures that the office spaces are comfortable and have efficiencies not possible in the section not yet renovated.

Site Plan of Existing Conditions

The following is a non detailed sketch of the Wedge 3 site plan. The building footprint, as well as RDF, or Remote Delivery Facility is shown, as well as the Route 110 road, the road which accesses the site and some of the areas involved in construction. These are labeled as the field trailers, the crane, trash chute, and others.



Project Delivery System

The Pentagon Wedge 3 is a contract that is separate from all other wedges' contracts. It is a design build project, with a fast track delivery. This was initially used for Wedge 2 construction and was successful, and will most likely be implemented throughout the remainder of the Pentagon Renovation.

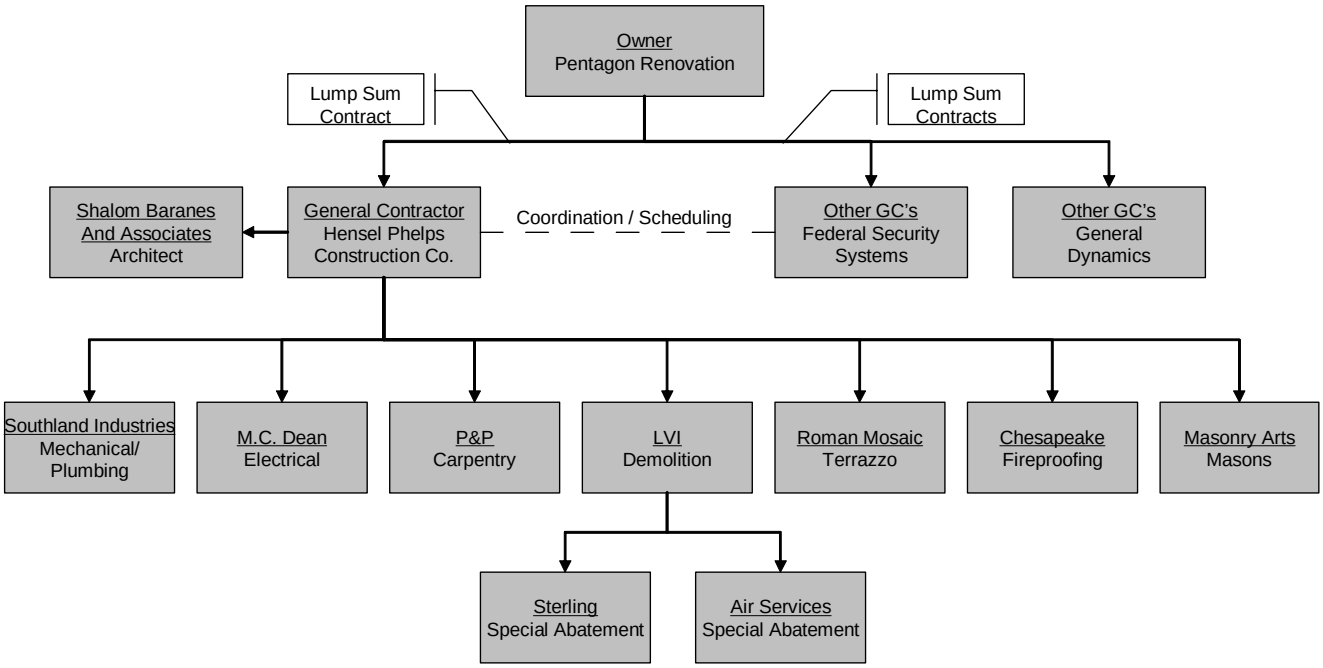
The owner, PenRen, has a lump sum contract with the main general contractor, Hensel Phelps, who in turn has lump sum contracts with each of its' subcontractors. It is written into the contract between PenRen and Hensel Phelps that if the work is not completed on time and to the expected specifications, the general contractor must cover the cost. Also, the general contractor is reviewed on a quarterly basis and is eligible for bonuses depending on how their work is being performed.

The following organizational chart makes visible the contractual bonds between the owner, the general contractor and architect, and the subcontractors involved.

Project Delivery System – Primary Contractors

Design Build

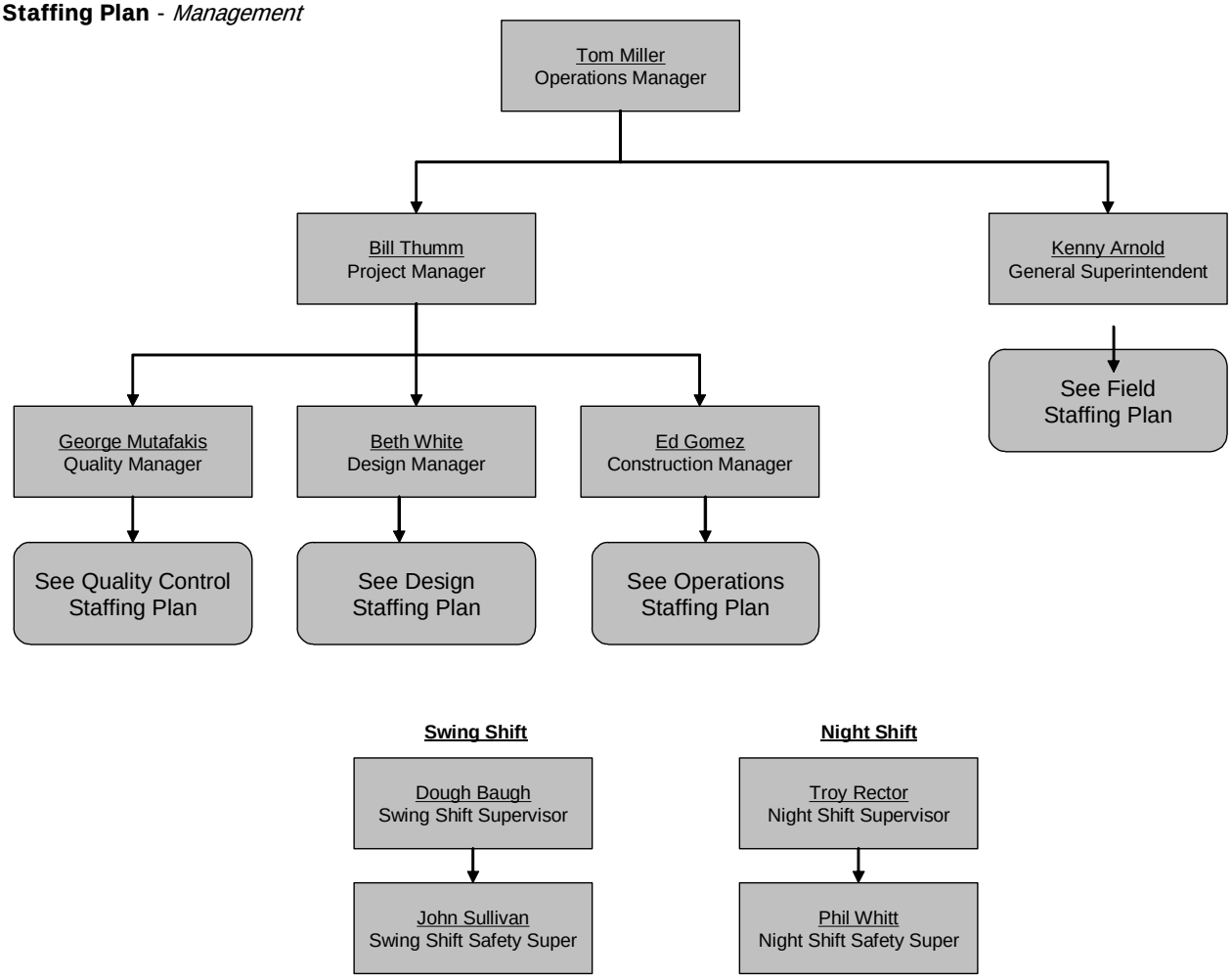
Fast Track



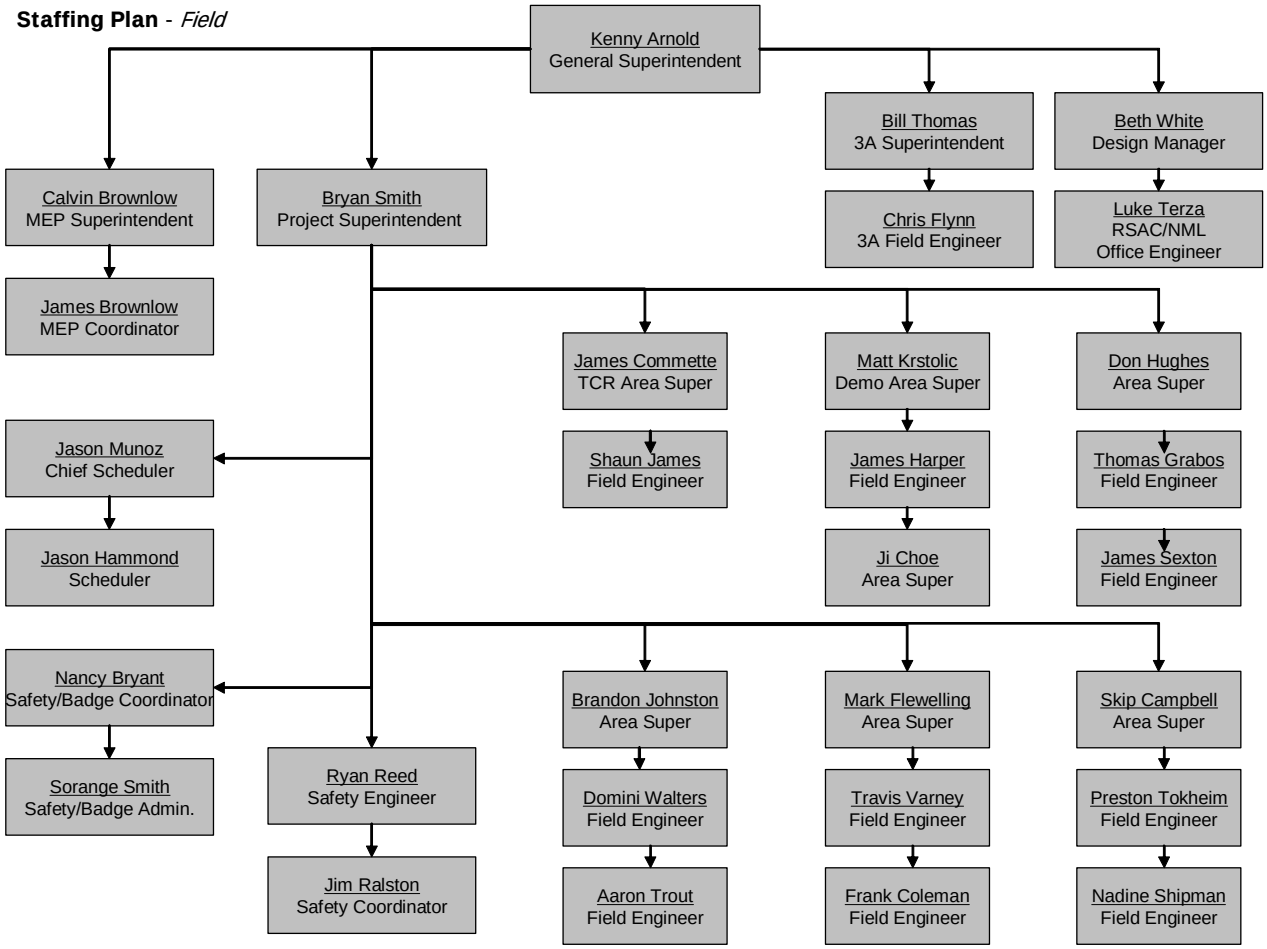
Staffing Plan

As shown in the following organizational charts, there is an abnormally large staff working for the general contractor, Hensel Phelps. The staff is lead by the operations manager, Tom Miller. He has other managers below him, each representing separate departments within the organization. These departments are Field, Operations, Design, and Quality Control, each shown with an individual chart for simplicty.

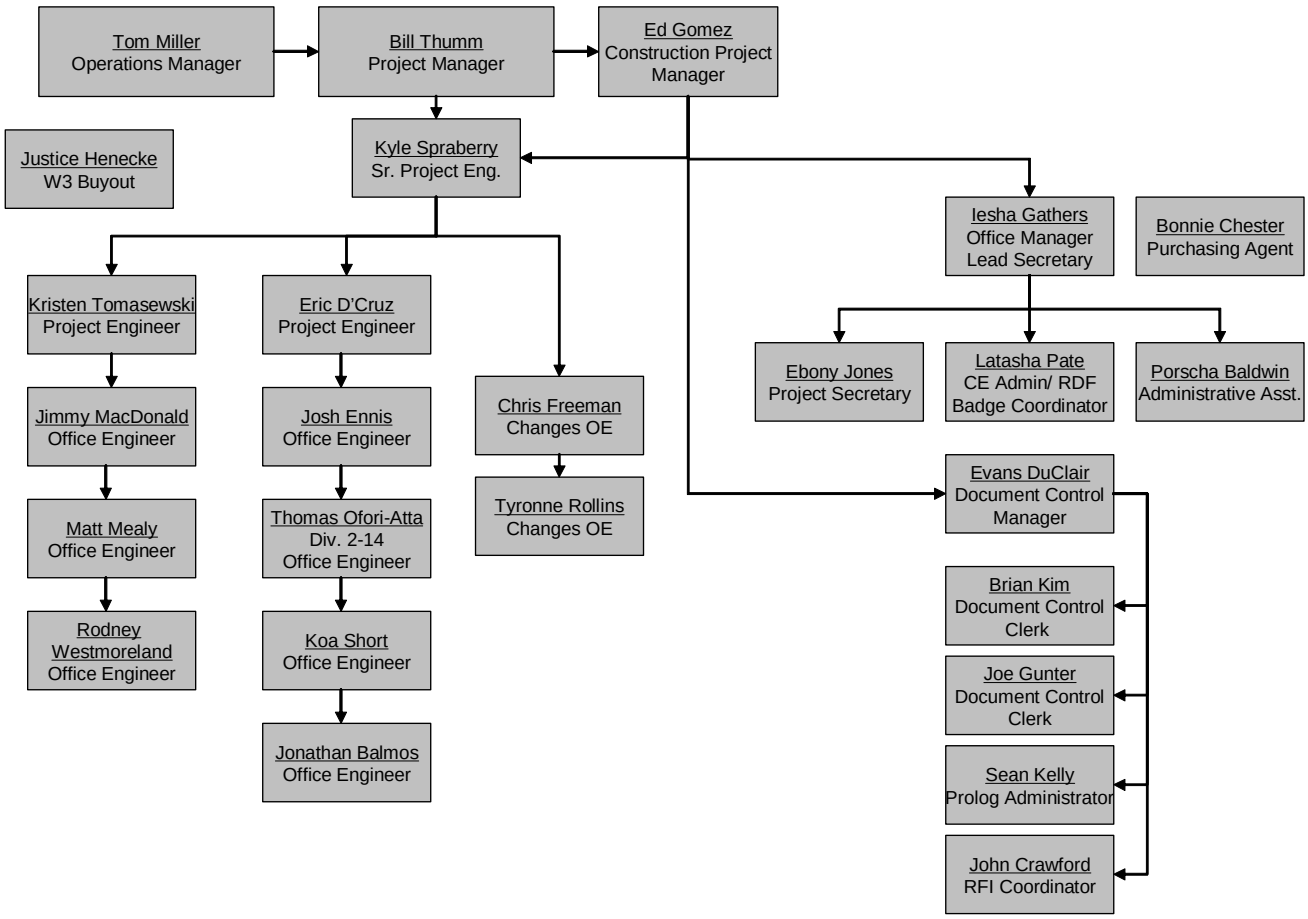
Staffing Plan - *Management*



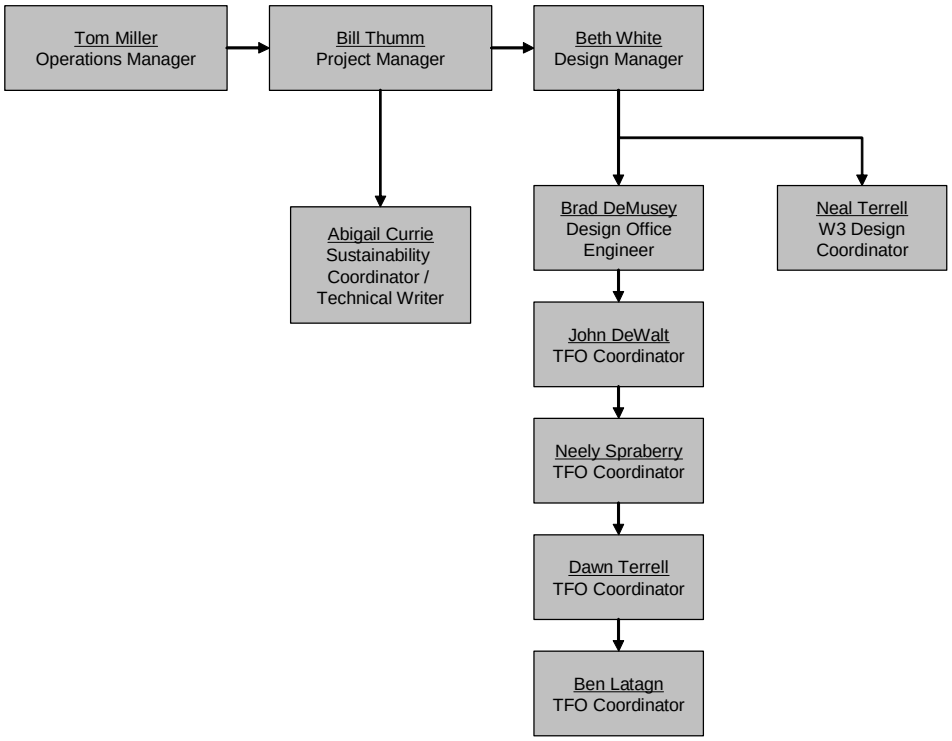
Staffing Plan - *Field*



Staffing Plan - *Operations*



Staffing Plan - *Design*



Staffing Plan – *Quality Control*