Research Facility Core and Shell

2012

Technical Report 1

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Executive Summary

Company growth and a need for expansion by the client, Faction, have resulted in the need for a new research facility on their existing campus. Located in the Southern California region, Faction's business involves research into new tools that can be used to study the human genome. Time is of the essence as researchers continue to request new and larger spaces to work in. The project would be called Research Facility Core and Shell and would be awarded to DPR Construction based on there already large presence at other sites on campus, existing relationships and a fair bid.

DPR was contracted under a GMP in two phases which consist of a core and shell package and a tenant improvement package. Only the core and shell package is under study in this technical report. The core and shell package is estimated to be a 127,373 SF four story steel structure with another level below grade. Included in the CS package as well are the building enclosure, heavy mechanical and electrical equipment, and site work totaling $20,035,000. Unique to this building is its varying array of exterior skins it exhibits alternating between curtain walls and various types of masonry veneer.

The project schedule was set for 18 months and the team is on track to meet that goal. The construction teams certainly took advantage of the favorable Southern California conditions, the large site, and the critical access ways in and out of the site. To meet the needs of the somewhat hasty schedule, DPR utilized BIM for coordination and clash detection. This early coordination in part, along with design decisions from the architect, allowed for the project to be built towards a LEED Silver standard. The project is currently on track to meet this goal as it nears the final stages of completion.

The Research Facility Core and Shell construction exhibits many qualities that could be open to debate and study. The GMP contract is effective but newer forms of contractual relationships are proving time and again that they can give better value to the client. DPR Construction and the owner have worked together multiple times in the past which might give merit to an IPD contract in this situation. Another item of interest is the owners need for such a varying and complex enclosure. Possible studies into the locations of the facades and how they can be rearranged could result in lower construction cost while still providing the same aesthetic appeal. One more item that is compelling is the MEP systems that are currently planned for use that largely ignore the outside environment. The Southern California region offers numerous forms of passive techniques that could be utilized for this building providing better working spaces and better energy efficiency.

Technical Report 1 is meant to give a better understanding of the project and its scope, the systems within, and the area where it is built. Contained in this report are details that will orient the reader with Research Facility Core and Shell and familiarize them with the project that will be under study for this researcher's senior thesis. Findings in this report were attained from interpretation of the project documents and interviews with engineers on site.

Table of Contents

Project Schedule Summary

The schedule for the Research Facility Core and Shell follows the normal construction sequence with a few modifications. Excavation and foundations went on with little difficulty as the soils in the area were well predicted. Also, the site is open which minimizes congestion with the equipment. Once foundations were complete, steel erection began.

The schedule depended heavily on how fast the steel could be erected which put pressure on the project team to line up all submittals and track the subcontractor for on-time completion. Once the main superstructure was erected, the curtain wall and exterior skin construction immediately began. All four sides of the building were raised simultaneously causing for a very busy 3 ½ months. Issues with water proofing details and control joints caused some delay here. The engineers at DPR were able to work with the architect to develop a new plan of action that remedied the problem, but with some delay.

While the exterior skin was going up, workers were busy on the inside doing MEP rough-in as well as interior construction/finishing. Being that RFCS is a core and shell only job, the MEP crews were able to work throughout the building in a low intensity environment at a fairly brisk pace. Once MEP was complete on a floor, interior construction began immediately which also only entailed a small scope. Simultaneously to both the skin and the interior work, rooftop mechanical equipment was being hoisted to its position. Once MEP work had reached about 50% completion, inspections and commissioning initiated allowing the team to meet its August 28th substantial completion deadline.

*Please see Appendix A for a more detailed project summary.

Building Systems Summary

The following section discusses the main building systems at RFCS. To begin, an initial checklist was completed to understand which systems were implemented as well as what questions needed to be answered on how they were constructed. Below is a table showing this initial check-up. Also contained in this section is a summary of the sustainability features that were incorporated to achieve a LEED Silver certification.

Table 1 Building System Summaries

Yes	No	Work Scope	Issues addressed
	x	Demolition	N/A
x		Structural Steel Frame	Type of bracing, member sizes, construction type
x		Cast in Place Concrete	Horiz. And Vert. Formwork types, concrete placement methods
	x	Precast Concrete	N/A
x		Mechanical System	Mech. Room locations, system type, types of distribution, types of fire suppression
x		Electrical System	Size/ capacity, redundancy
x		Masonry	Load bearing or veneer, connection details, scaffolding
x		Curtain Wall	Materials included, construction methods, design responsibility
x		Support of Excavation	Type of excavation support system, dewatering system, permanent vs. temporary
x		LEED Certification	Sustainability features

Structural Steel Frame

The main superstructure at RFCS consists of structural steel. It rests on 42 spread footings sized mainly at 11'x11' supporting the structure with a CMU wall running the perimeter of the basement bearing the load from the soil. The design is straight forward following a redundant bay scheme. Composite metal deck rests on the steel beams topped with 3 ½" normal-weight concrete. A relatively new form of lateral bracing was used on this building. It is called a "side-plate" system and involves using steel side plates to horizontally brace and connect the perimeter columns to one another. An image taken from the manufacturer's website can be seen below. The most common beam used throughout the building is a W21x44 spanning 42 ½ feet and running N-S. The girders that these beams rest on are typically W27x84 and run E-W. Columns are spaced in a typical pattern with the largest being W12x120.

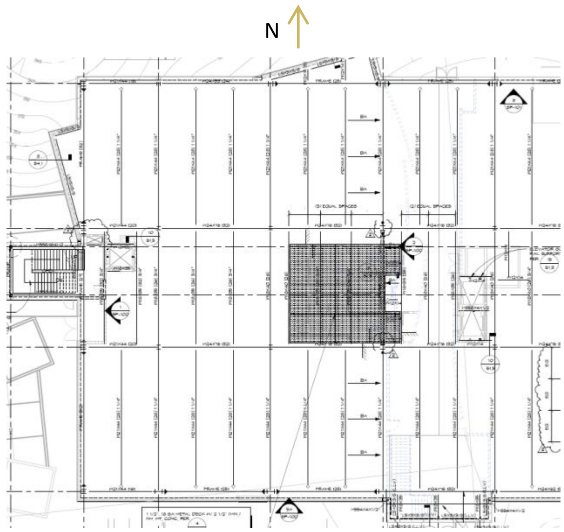


Figure 1 Typical Steel Bays

Figure 2 SidePlate System www.sideplate.com

Cast in Place Concrete

Cast in Place concrete was utilized for the foundation, slab on grade, and floor slabs. Classic wooden formwork was used for the foundation and SOG while an edge plate was built into the structure to allow for the pours onto metal deck. Trucks delivered the concrete to site allowing for direct pours for the foundation and SOG. A pump was utilized for floors 1-4 due to the elevations.

Mechanical System

The portion of RFCS that is being studied incorporates only the main “core” of the mechanical system which entails large rooftop units with large ducts that travel down the main vertical chase of the building. While the scope of work is small, at this phase in the project is when the main drivers of what the mechanical system will be are installed. The core portion of the HVAC system is comprised of 4 rooftop air handling units utilizing central chilled water via a main plant on the Faction campus and will service hot water via two 4-ton rooftop boilers. A smaller mechanical/utility room is located at the garage level but most of the service will occur at the rooftop level. A large vertical chase runs from the rooftop to the garage allowing for an organized flow of ductwork and piping. This chase is located at the center of the building next to the restrooms.

Electrical System

Five hundred feet of newly installed high voltage lines connect three transformers (3000KVA, (2) 1500KVA) to the existing Faction campus power; this can be seen in the figure below. Two newly constructed man holes on the south end of the building serve as this tie in. The power travels from the transformers to a 4000 A switchgear and a 2500 A switchgear that serve the power needs of the building. The electrical scope for the core and shell portion of the building was kept to the main power components. Further installations for the smaller distribution have been built into the Tenant Improvement contract.

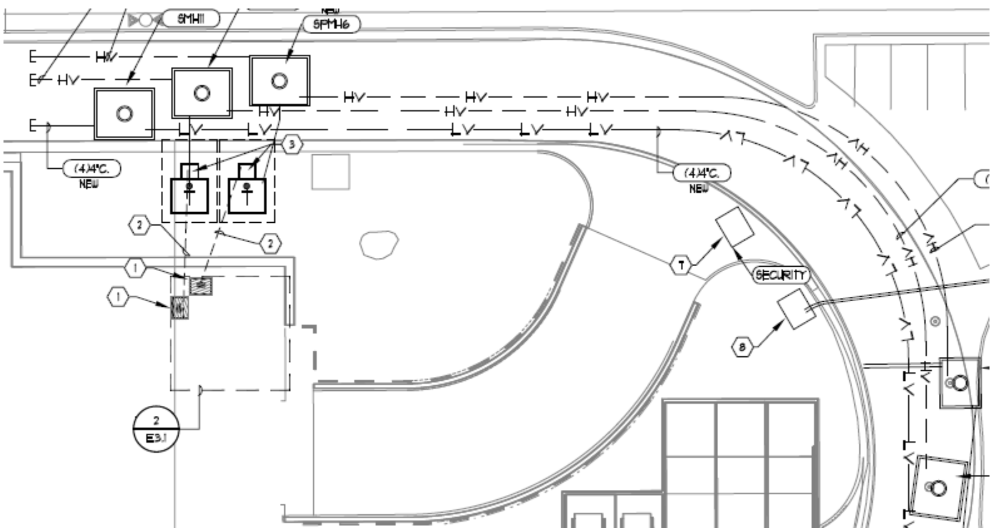


Figure 3 New High Voltage Lines

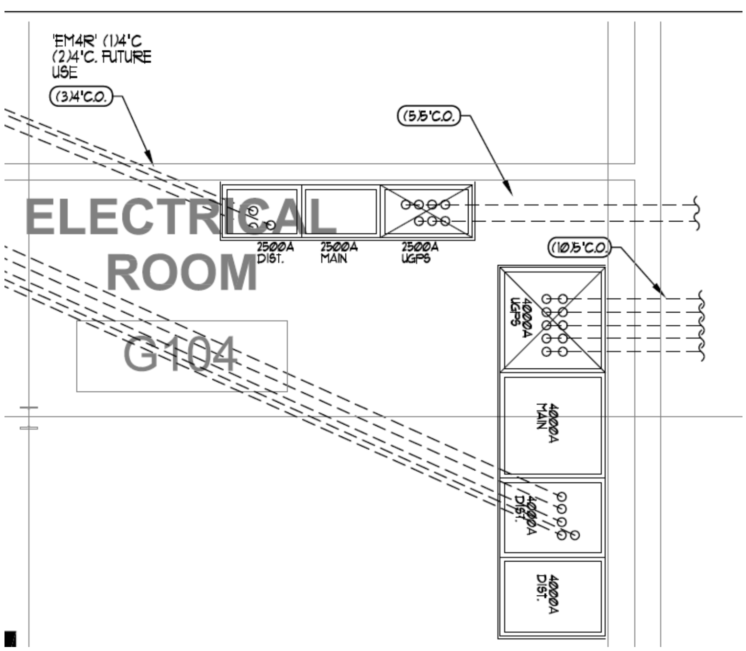


Figure 4 Main Electrical Room

Masonry

RFCS is heavily characterized by its masonry components. Concrete Masonry Units are used to support the soil loads in the basement and run the perimeter of the building below grade. Various types of masonry veneer were used on the enclosure of the building which can be seen in the figure below. All of which were about 6"x12"x 1" pieces of stone attached one by one to the metal stud wall assembly. Stick built scaffolding was used and all four sides of the building went up simultaneously.

Figure 5 Masonry Walls

Curtain Wall

Aside from the masonry that was used for the enclosure, curtain walls constituted a large portion as well. These curtain walls consisted of steel mullions that supported windows that were mainly 4'x8' and were composed of clear blue "vision" glass. The curtain walls were built on the ground and raised as panels. Once raised, they were tied into the structure at connection points on each floor.

Figure 6 Curtain Wall

Support of Excavation

RFCS has one level below grade that will eventually be a parking garage. This requires excavation which could be a potential hazard if not addressed appropriately. To prevent from any cave-ins, the construction team set back the perimeter of the excavation where space permitted and used sheathing and shoring in areas that were more restrictive on space. Dewatering was unnecessary during construction both permanently and temporarily.

LEED Goals

From the very start of the project it was important to the owner to be as sustainable as possible and meet LEED standards. The core and shell is on track for attaining LEED silver certification. Recycled insulation boards are used on the roof and layered twice which saves materials as well as increases the thermal properties of the building. Along with this, white EPDM membrane is used on the roof to decrease the heat island effect. The thermal properties of the enclosure also prove to be proficient and will save energy through time when compared to a normal system. Adding to the sustainability features mentioned above are the typical LEED point gainers such as showers on the first floor and bike racks outside to promote greener forms of transportation.

Project Cost Evaluation

The following section outlines the actual construction costs for Research Facility Core and Shell and compares them to both a square foot estimate and an assemblies estimate. The estimates were performed by Tim Maffett on September 15th 2012 using RS Means construction cost data. A more detailed estimate breakdown can be found in Appendix B.

Actual Construction Costs

Table 2: Actual Project Costs

Major Costs for Research Facility Core and Shell		
	Construction Cost	**Cost/SF**
Actual Building Construction	$16,031,402	$125.86
Total Project	$20,035,000	$157.29
Mechanical System	$1,574,261	$12.36
Electrical System	$1,014,666	$7.97
Plumbing System	$662,250	$5.20
Fire Protection	$298,462	$2.34
Structural System	$5,238,945	$41.13
Exterior Skin	$4,089,261	$32.10

*Actual Building Construction pricing does not include land costs, site work, permitting, insurance, general conditions or fee.

*Total Project includes land costs, site work, permitting, insurance, general conditions, and fee.

Square Foot Estimate

Table 3 Square Foot Estimate

Square Foot Costs for Research Facility Core and Shell		
	Construction Cost	**Cost/SF**
Total Project	$19,857,928	$194.88

Assemblies Estimate

Table 4 Assemblies Estimate

Assemblies Costs for Research Facility Core and Shell		
	Construction Cost	**Cost/SF**
Mechanical System	$2,496,510.80	$19.60
Electrical System	$203,504.10	$1.60
Plumbing System	$146,924.22	$1.15
Fire Sprinkler System	$415,235.98	$3.26

The Research Facility Core and Shell costs are mostly associated with the superstructure and exterior skin rather than the typically large MEP budgets. This is due to the owner's decision to split the project up into two phases, a Core and Shell and a Tenant Improvement. Because of this split, estimates besides a detailed estimate prove to be very difficult to quantify.

The square foot estimate was based on a typical Office Building 2-4 stories. This is due to the Superstructure being very similar to that of an office building. Once adjustments were made and calculated for things like story height, location, and wall types, the estimated percentage of mechanical and electrical systems that are not included in the CS were removed allowing for a very close match SF estimate.

On the other hand, the assemblies estimate proved to be unreliable. The estimate varies from actual costs due to the split in MEP scopes. This semi-unorthodox split caused difficulties when trying to pick an appropriate assembly system from RS Means. The assemblies estimate accounted for items that were not included in the Core and Shell package in some instances and did not account for things in other instances. A detailed estimate would prove to be very effective for a building of this nature as the amount of items to count in the MEP system is minimal. Another issue associated with the assemblies estimate is that it does not include the piping, conduit, and duct work that is needed in the building; this certainly causes a difference between the estimate and the actual costs.

Existing Conditions

*Detailed plans can be found in Appendix C – Existing Conditions Plan and Phasing Plans

The existing conditions of this site did not provide too many obstacles for the construction team. Of necessary items to focus on though include the need to address pedestrian traffic and the need for finding exact utility tie-in point locations. It is important that pedestrians on campus are informed and kept as far away from the construction as possible. The fence location and associated walking paths create a boundary for this which should manage walking traffic as best as possible. Existing utility tie-in points must be found in order to connect the new lines to the RFCS. Often times the As-Built drawings are imprecise so it is imperative that the team does proper investigation and takes caution when digging for these.

Site Layout Planning

*Detailed plans can be found in Appendix C – Existing Conditions Plan and Phasing Plans

Excavation

Critical items that must be addressed during the excavation process include vehicular traffic such as dump trucks, disturbing underground utilities, and on site caution from heavy equipment. Dump trucks must be coordinated to follow a one way pattern from the north side of site travelling around and southward as can be seen on the Building Excavation Plan. When digging the excavators must exercise caution near utilities and workers must also be conscientious of one another while the heavy equipment is in operation.

Superstructure

The site allows for a relatively safe erection of the superstructure. Again, trucks must enter from the north and exit on the south side. Space is available for concrete trucks to back in from the fire lane and make the appropriate pours for the foundations and SOG. Crews can erect the structure from north to south using a crawler crane with a swing radius of 75’. Steel laydown areas are ample and can even move with the crane as it works its way south. The crane operator must be cautious when erecting the south end of the building as Existing Building A is close enough that it could be threatened if a control mistake was made.

Enclosure

The logistics plan for the enclosure is quite similar to that of the superstructure. The crane will still need to be in operation to raise the north side curtain wall. Stick built scaffolding surrounds the remaining walls to allow the entire enclosure to be erected as speedily as possible. Materials for the masons and other crews can be placed where the steel had been or next to it if steel materials are still left. At this point in the project crews must be especially cautious of one another. Multiple trades are on site and will be working in close vicinity of one another.

Local Conditions

The conditions of this Southern California site are quite favorable for construction. Owners and contractors benefit from the almost always sunny weather with almost no rainy days (10 inches per year on average). The Faction campus is also very spacious allowing for a large site with gracious lay down space and tie-ins to an existing central utility plant. Adding to these conveniences is an existing parking lot that is next to the site which allows space for trailers as well as parking for employees, craftsman and labors. This clears the actual site, opening it even further for the trades to efficiently work. An existing fire lane that passes the site allows for easy entrance and exit for vehicles such as dump trucks, concrete trucks, and delivery trucks. As one might expect, the soil in the area remains dry which was a benefit to the project team as they did not have to pump water during excavation. The consistently sandy soil of the area also gave ease to the excavation process as well as the predictability of avoiding unforeseen conditions.

Figure 7 Aerial View of Site www.Bing.com

The area where RFCS is located has both steel and concrete structures spread throughout. While both exist, steel construction is by far the most preferred method of construction; especially on the Faction campus. The low building height of surrounding buildings as well as the large spacing of the campus allows for safe and more efficient crane picks during steel erection. One would be hard pressed to find a site to construct their new building on as favorable as this one and the team certainly used this to their advantage.

Client Information

Faction is a company with highly vested interests into the study of genes and the biologic functions resulting from genetics. Their line of products that will be under investigation in the new RFCS does not deal with the actual study of genetics but rather- the study of *the tools* that are needed to closely examine genetics. The campus is dedicated to providing a space for ingenuity and contains buildings such as a gym, a café, and an amphitheater that is currently under construction on the north side of RFCS. Faction not only incorporates this attitude into specialized buildings on campus but also tries to work that feeling into their research labs. Because of this, they want the spaces to be detailed and pleasant to be in. They have worked with the designer to allow for large open spaces for research as well as architecturally pleasing finishes such as an intricate lobby space that evokes a feeling of compression and expansion immediately upon entry.

The need for the RFCS arose mainly out of company growth but the extraordinarily speedy pace of the technology industry contributed as well. Faction has held specific construction needs throughout the building process. Schedule has been a driving factor for the project because of the amount of money that can be generated by the scientists once occupied. This has contributed to a very hectic core and shell schedule pushing for a very quick turn-around. Along with schedule, safety is a very important component of what the owner/tenant would call a successful project. The company exists to find new products that will help other scientists look closer at our genome which consequently leads to saving lives. Having a death during construction would be an enormous tragedy and the contractor would certainly see the repercussions.

Sequencing has become a large part of this project as well. The owner continues to push for phased occupancy to allow for research to start as soon as possible. Because of this, the project was split into core and shell and tenant improvement. The reasoning behind this was to reach a contractual agreement with DPR on scopes that could be properly bought, managed, and released in a speedy manor while still holding a design-bid-build contract. While DPR builds the CS, the TI scope and contract are negotiated. If one were to look at both the CS and TI together as one contract it would look very similar to a fast-track construction method. This is not the case though and seems to have been done so intentionally by the owner.

Project Delivery System

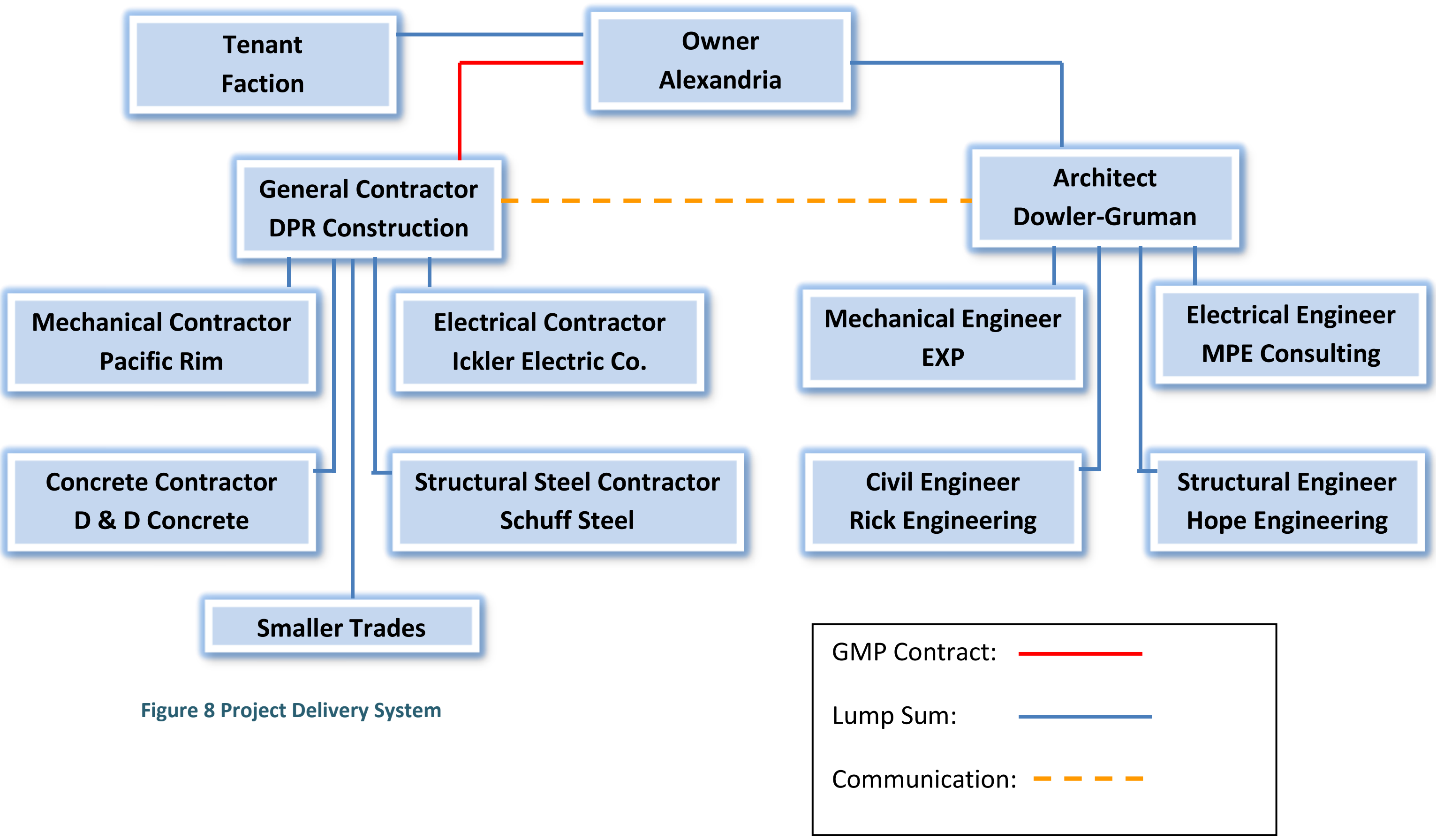


Figure 8 Project Delivery System

The Research Facility Core and Shell is being delivered as a "design-bid-build". Faction uses this delivery method because it is a familiar approach used by the organization and has proven to be successful for other buildings on their campus. DPR has built a strong relationship with the Client and has built many of the existing buildings on the campus. The trust factor, DPR's presence on campus, and a fair bid, allowed DPR to win the job.

DPR has been contracted under a GMP by Alexandria. DPR then contracts the subcontractors based on a lump sum. Dowler-Gruman, the Architect, has been contracted under a lump sum and holds its engineering consultants under lump sum contracts as well. DPR is in constant communication with Dowler-Gruman exchanging RFI's, submittals, and working out some of the issues in constructability.

Subcontractors were chosen based on lowest bid, safety plans, and their ability to build the project. DPR is concerned with more than just the lowest bid. Safety is of utmost concern as well as the promise to complete the work and the need for complete bonds and insurance to cover any failure to do so.

Staffing Plan

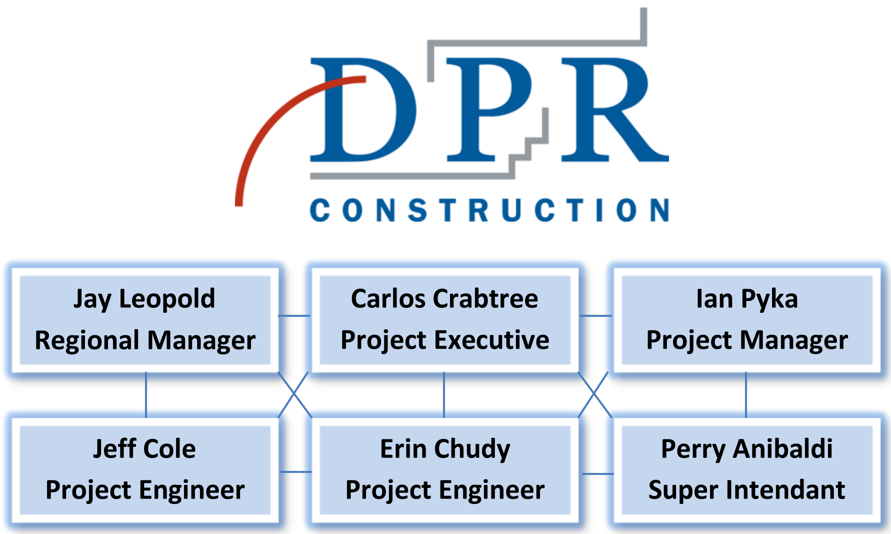


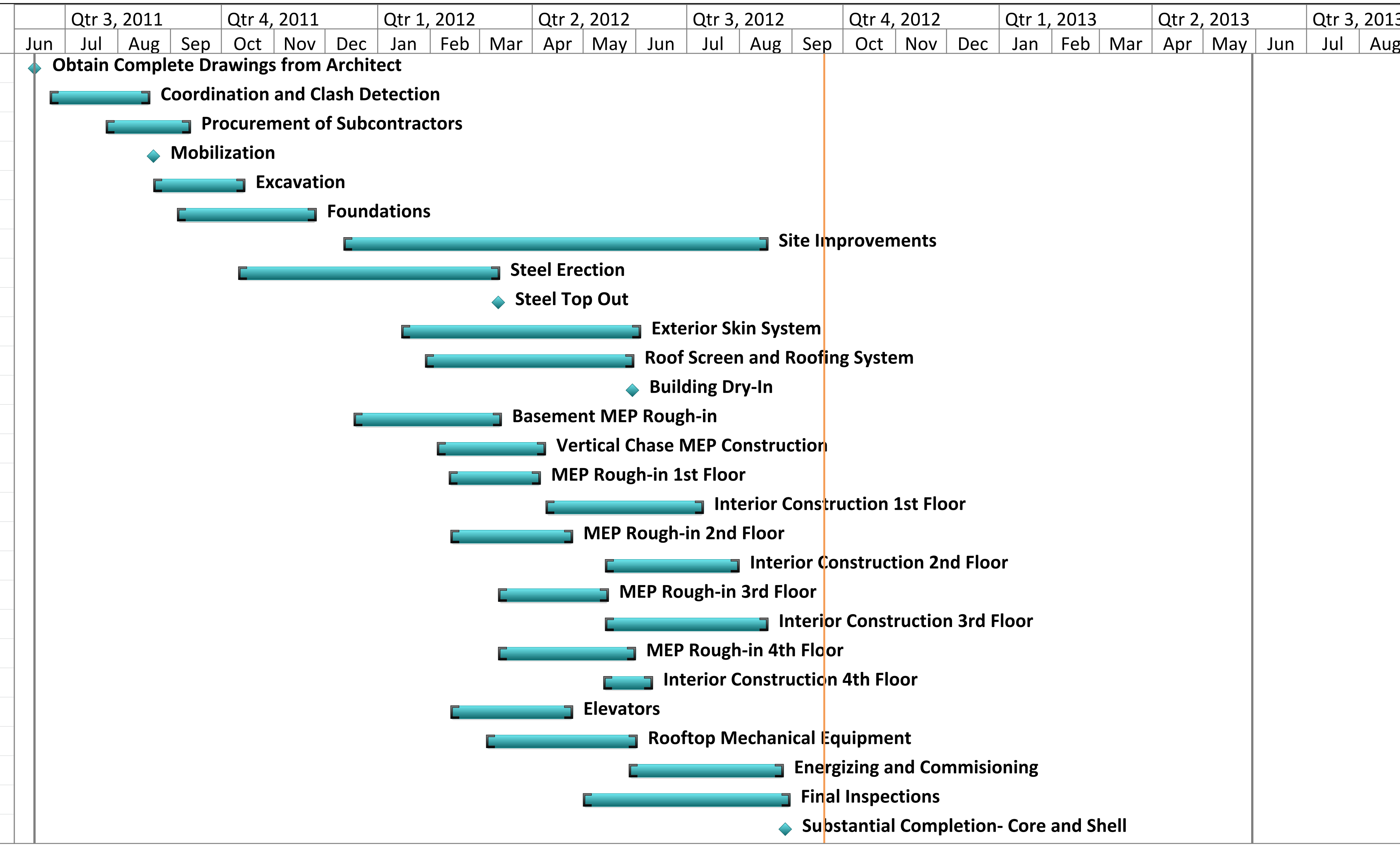
Figure 9 Staffing Plan

DPR operates as a flat organization relying on the team to "break down the silos". To do so they chose not to have formal titles or formal bosses. The titles listed above have been used to represent the main role of the individual and the lines linking the boxes have been interconnected to show that each individual on the DPR team is responsible for answering to one another.

Jay Leopold is the Regional Manager of the San Diego office and oversees all of the projects that are going on in the greater San Diego region. Managing the entire campus of buildings for the Owner is Carlos Crabtree. The project manager for the entire campus and more specifically the Research Facility Core and Shell is Ian Pyka. Ian is in charge of the finances on the project and also holds a very "in touch" relationship with the owner. Erin Chudy and Jeff Cole are the Project Engineers responsible for the day to day management that takes place while Perry Anibaldi leads the charge as Super Intendant responsible for managing the crews on site. Erin Chudy has taken a lead on the core and shell as project engineer and Jeff Cole has assumed the responsibility of the MEP systems.

Appendix A- Project Schedule

ID	Task Name	Duration	Start	Finish
1	Obtain Complete Drawings from Architect	0 days	Mon 6/13/11	Mon 6/13/11
2	Coordination and Clash Detection	43 days	Wed 6/22/11	Fri 8/19/11
3	Procurement of Subcontractors	36 days	Mon 7/25/11	Mon 9/12/11
4	Mobilization	0 days	Mon 8/22/11	Mon 8/22/11
5	Excavation	40 days	Mon 8/22/11	Fri 10/14/11
6	Foundations	60 days	Mon 9/5/11	Fri 11/25/11
7	Site Improvements	180 days	Mon 12/12/11	Fri 8/17/12
8	Steel Erection	110 days	Tue 10/11/11	Mon 3/12/12
9	Steel Top Out	0 days	Mon 3/12/12	Mon 3/12/12
10	Exterior Skin System	102 days	Sun 1/15/12	Sun 6/3/12
11	Roof Screen and Roofing System	89 days	Sun 1/29/12	Wed 5/30/12
12	Building Dry-In	0 days	Wed 5/30/12	Wed 5/30/12
13	Basement MEP Rough-in	63 days	Sun 12/18/11	Tue 3/13/12
14	Vertical Chase MEP Construction	47 days	Sun 2/5/12	Sun 4/8/12
15	MEP Rough-in 1st Floor	40 days	Sun 2/12/12	Thu 4/5/12
16	Interior Construction 1st Floor	67 days	Mon 4/9/12	Tue 7/10/12
17	MEP Rough-in 2nd Floor	52 days	Mon 2/13/12	Tue 4/24/12
18	Interior Construction 2nd Floor	57 days	Mon 5/14/12	Tue 7/31/12
19	MEP Rough-in 3rd Floor	47 days	Mon 3/12/12	Tue 5/15/12
20	Interior Construction 3rd Floor	70 days	Mon 5/14/12	Fri 8/17/12
21	MEP Rough-in 4th Floor	59 days	Mon 3/12/12	Thu 5/31/12
22	Interior Construction 4th Floor	22 days	Sun 5/13/12	Sun 6/10/12
23	Elevators	52 days	Mon 2/13/12	Tue 4/24/12
24	Rooftop Mechanical Equipment	65 days	Mon 3/5/12	Fri 6/1/12
25	Energizing and Commisioning	66 days	Mon 5/28/12	Sun 8/26/12
26	Final Inspections	88 days	Tue 5/1/12	Thu 8/30/12
27	Substantial Completion- Core and Shell	0 days	Tue 8/28/12	Tue 8/28/12



Project: Project Schedule Summa
Date: Thu 9/20/12

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

Appendix B: Cost Evaluation

Table 5 Square Foot Estimate

Square Foot Estimate	
Appraisal Information	
Gross Floor Area (excl. basement)	127,373 SF
Basement Area	31,917 SF
Perimeter	734 ft
Story Height 1st, 2nd, 3rd	16 ft
Story Height 4th	20 ft
Story Height Avg.	17 ft
Exterior Wall Construction	
South, East, West Wall	Metal stud with punch windows and stone veneer
Closest Comparable	Face brick veneer on steel studs w/ Steel Frame
North Wall	Glass and Metal Curtain Wall
Closest Comparable	Glass and Metal Curtain Wall w/ Steel Frame
Frame	Steel
Estimate Breakdown	
Adjustments for Exterior Wall Variation	
North Wall Percentage of Perimeter	33%
South, East, and West Wall Percentage of Perimeter	67%
Interpolated Wall Price	170.12 $/SF
Height Adjustment	5(1.05) = 5.25 $/SF extra
Perimeter Adjustment	1.5(2.40) = 3.6 $/SF extra
Adjusted Base Cost per square foot	178.97 $/SF
Building Cost	178.97*127,373 = $22,795,950
Basement Cost	35.20*31917= $1,123,478.4
Total Building Cost	$24,099,429
Location Modifier	x1.03
Less Depreciation	0
Total Cost before estimated to Core and Shell	24822410
Remove 20% for Mechanical and Electrical	(.2*24,822,410)
Final Total Cost	**$19,857,928**

*Adjustments for the square foot estimate can be seen in the table above.

*Based on RS Means % breakdown information on mechanical and electrical as well as the need to incorporate some of these systems, 20% reduction was chosen as an average.

Assemblies Estimate							
Assembly Category/ Number	**Description**	**Quantity**	**Unit**		**Cost/Unit**		**Grand Total Incl. O & P**
Plumbing							
D 2010 110 1880	Water closet, vitreous china, elongated tank type, wall hung, two piece	32	Ea	$	2,467.07	$	78,946.24
D2010 210 2000	Urinal, Vitreous China, Wall Hung	8	Ea	$	1,424.50	$	11,396.00
D2010 310 1560	Lavatory w/ Trim, Wall hung, PE on Cl, 18" x 15"	18	Ea	$	1,710.00	$	30,780.00
D2010 710 1560	Shower, stall, baked enamel, molded stone receptor	2	Ea	$	2,108.54	$	4,217.08
D2020 240 1820	Electric water heater, commercial, 100 deg F rise, 50 gal tank, 9KW, 37 GPH	2	Ea	$	6,188.65	$	12,377.30
D2040 210 1880	Roof Drain, DWV PVC Pipe, 2" Diam., 10' High	10	Ea	$	920.76	$	9,207.60
Subtotal						**$**	**146,924.22**
HVAC							
D3020 104 1400	Large heating systems, electric boiler, 666 K.W., 2,273 MBH, 4 floors, piping & accessories incl.	127373	SF	$	9.27	$	1,180,747.71
D3050 165 3200	Medical Centers 33.33 ton weight AHU w/ 15% reduction bc chilled water is sent from central plant	127373	SF	$	10.33	$	1,315,763.09
Subtotal						**$**	**2,496,510.80**
Fire Sprinkler							
D4010 310 0740	Dry pipe sprinkler, steel, black, Sch 40 pipe, light hazard,multiple floors, >10,00 SF/floor	127373	SF	$	3.26	$	415,235.98
Subtotal						**$**	**415,235.98**
Electrical							
D5010 240 0410	Switchgear installation, incl. swbd., panels and circ bkr, 2000 A, 277/480 V	3	Ea	$	67,680.00	$	203,040.00
D5020 208 1800	Fluorescent fixtures mount 9'11" above floor, 100 FC, type b, 11 fixtures per 400 SF	34	Ea	$	13.65	$	464.10
Subtotal						**$**	**203,504.10**
Grandtotal						**$**	**3,262,175.10**

Table 6 Assemblies Takeoff

Assemblies Takeoff			
Plumbing System	**Quantity**	**Electrical System**	**Quantity**
50 Gallon Electric Hot Water Heater	2	3000 KVA Transformer	1
2 GPM 85 W Hot Water Pump	2	1500 KVA Transformer	2
1st Floor		1st Floor	
Wall Mounted Toilet	8	Flourescent Lights	10
Wall Mounted Urinal	2	2nd Floor	
Wall Mounted Sink	6	Flourescent Lights	8
Shower	2	Sconce Lighting	4
2nd Floor		3rd Floor	
Wall Mounted Toilet	8	Flourescent Lights	8
Wall Mounted Urinal	2	4th Floor	
Wall Mounted Sink	4	Flourescent Lights	8
Shower	0	**Mechanical System**	**Quantity**
3rd Floor		Roof	
Wall Mounted Toilet	8	Air Handler: 50,000 CFM SA, 46,000 CFM RA	2
Wall Mounted Urinal	2	HW Boiler: 80% eff, 140 GPM, Output 2080 MBH	2
Wall Mounted Sink	4	HW Pump: Inline, 140 GPM 61% eff	2
Shower	0	HW Pump: End Suction, 280 GPM, 75 % eff	2
4th Floor		**Fire Sprinkler**	**Quantity**
Wall Mounted Toilet	8	Dry Pipe System	1
Wall Mounted Urinal	2		
Wall Mounted Sink	4		
Shower	0		

Assumptions

*The 3000 KVA and two 1500 KVA transformers equaled the KVA produced by three 2000 KVA transformers and since RS Means has listed only the 2000 KVA system, it was estimated that the cost can be compared on this basis.

COMMERCIAL/INDUSTRIAL/ INSTITUTIONAL | M.460 | Office, 2-4 Story

Costs per square foot of floor area

Exterior Wall	S.F. Area	5000	8000	12000	16000	20000	35000	50000	65000	80000
	L.F. Perimeter	220	260	310	330	360	440	490	548	580
Face Brick with Concrete Block Back-up	Wood Joists	250.75	218.75	200.50	187.80	181.10	167.80	161.40	158.20	155.50
	Steel Joists	254.20	222.20	203.95	191.25	184.55	171.25	164.90	161.65	158.95
Glass and Metal Curtain Wall	Steel Frame	298.50	256.35	232.20	214.90	205.90	187.80	179.00	174.60	170.85
	R/Conc. Frame	294.70	253.10	229.25	212.10	203.20	185.30	176.55	172.15	168.40
Wood Siding	Wood Frame	200.15	177.50	164.65	156.10	151.60	142.75	138.55	136.50	134.75
Brick Veneer	Wood Frame	222.25	193.85	177.60	166.55	160.65	149.05	143.50	140.70	138.40
Perimeter Adj., Add or Deduct	Per 100 L.F.	38.20	23.95	15.95	11.85	9.55	5.50	3.80	2.90	2.40
Story Hgt. Adj., Add or Deduct	Per 1 Ft.	6.25	4.65	3.65	2.90	2.55	1.80	1.35	1.20	1.05

***For Basement**, add $35.20 per square foot of basement area*

The above costs were calculated using the basic specifications shown on the facing page. These costs should be adjusted where necessary for design alternatives and owner's requirements. Reported completed project costs, for this type of structure, range from $70.40 to $272.80 per S.F.

Common additives

Description	Unit	$ Cost
Closed circuit surveillance, one station		
Camera and monitor	Each	1925
For additional camera stations, add	Each	1025
Directory boards, plastic, glass covered		
30" x 20"	Each	645
36" x 48"	Each	1475
Aluminum, 24" x 18"	Each	615
36" x 24"	Each	725
48" x 32"	Each	1025
48" x 60"	Each	2150
Electronic, wall mounted	S.F.	895
Free standing	S.F.	1175
Escalators, 10' rise, 32" wide, glass balustrade	Each	137,300
Metal balustrade	Each	143,300
48" wide, glass balustrade	Each	143,300
Metal balustrade	Each	150,800
Pedestal access floor system w/plastic laminate cover		
Computer room, less than 6000 SF	S.F.	11.90
Greater than 6000 SF	S.F.	11.15
Office, greater than 6000 S.F.	S.F.	7.95

Description	Unit	$ Cost
Security access systems		
Metal detectors, wand type	Each	98
Walk-through portal type, single-zone	Each	3750
Multi-zone	Each	4700
X-ray equipment		
Desk top, for mail, small packages	Each	3850
Conveyer type, including monitor, minimum	Each	17,500
Maximum	Each	31,100
Explosive detection equipment		
Hand held, battery operated	Each	28,100
Walk-through portal type	Each	47,900
Uninterruptible power supply, 15 kVA/12.75 kW	kW	1720

Important: See the Reference Section for Location Fact

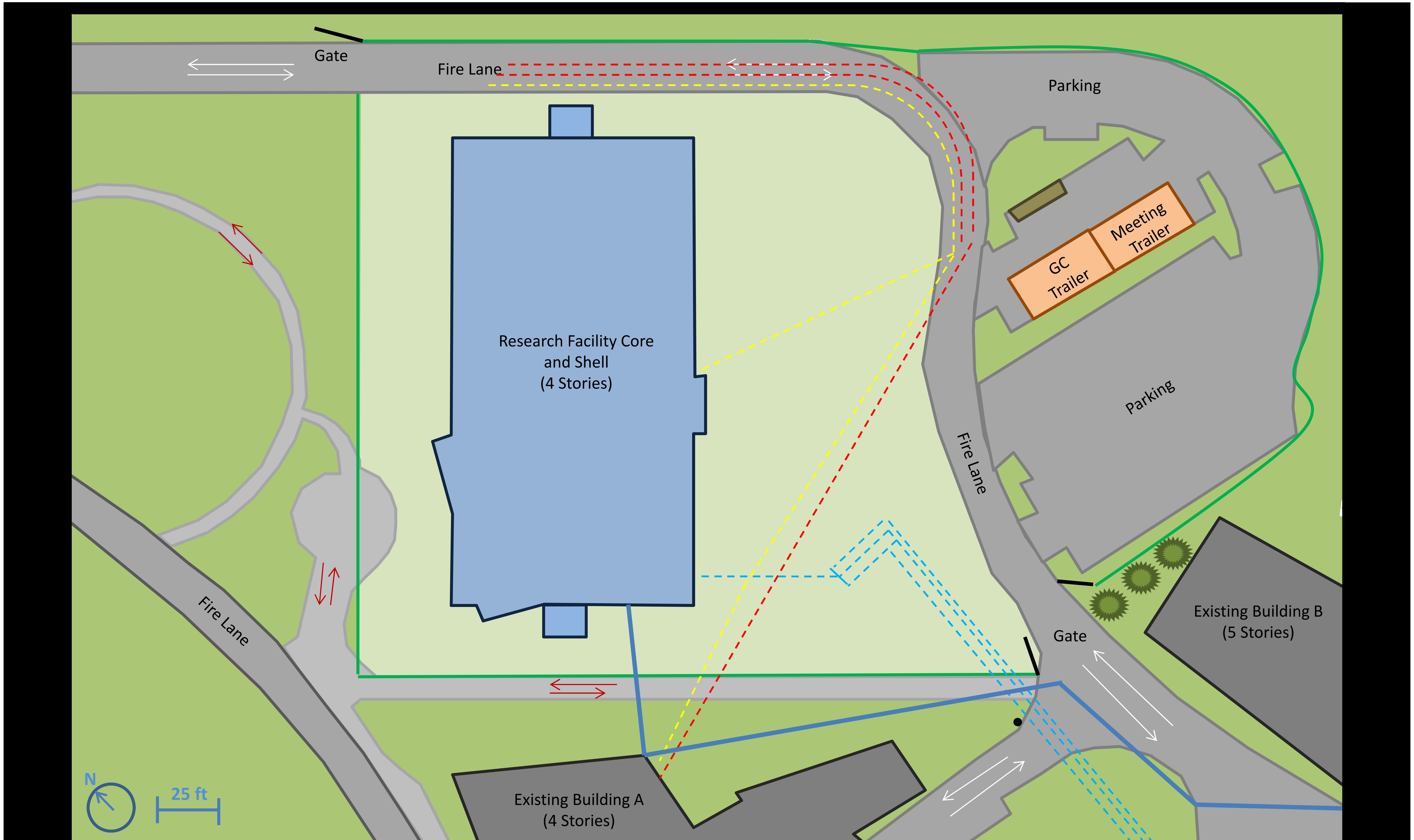
Model costs calculated for a 3 story building with 12' story height and 20,000 square feet of floor area

Office, 2-4 Story

				Unit	Unit Cost	Cost Per S.F.	% Of Sub-Total
A. SUBSTRUCTURE							
1010	Standard Foundations	Poured concrete; strip and spread footings		S.F. Ground	7.41	2.47	4.3%
1020	Special Foundations	N/A		—	—	—	
1030	Slab on Grade	4" reinforced concrete with vapor barrier and granular base		S.F. Slab	5.11	1.70	
2010	Basement Excavation	Site preparation for slab and trench for foundation wall and footing		S.F. Ground	.18	.06	
2020	Basement Walls	4' foundation wall		L.F. Wall	76	1.69	
B. SHELL							
	B10 Superstructure						
1010	Floor Construction	Open web steel joists, slab form, concrete, columns		S.F. Floor	18.20	12.13	10.4%
1020	Roof Construction	Metal deck, open web steel joists, columns		S.F. Roof	6.84	2.28	
	B20 Exterior Enclosure						
2010	Exterior Walls	Face brick with concrete block backup	*80% of wall*	S.F. Wall	31.91	16.54	15.7%
2020	Exterior Windows	Aluminum outward projecting	*20% of wall*	Each	727	4.09	
2030	Exterior Doors	Aluminum and glass, hollow metal		Each	3418	1.04	
	B30 Roofing						
3010	Roof Coverings	Built-up tar and gravel with flashing; perlite/EPS composite		S.F. Roof	6.69	2.23	1.6%
3020	Roof Openings	N/A		—	—	—	
C. INTERIORS							
1010	Partitions	Gypsum board on metal studs	*20 S.F. Floor/L.F. Partition*	S.F. Partition	9.45	3.78	23.2%
1020	Interior Doors	Single leaf hollow metal	*200 S.F. Floor/Door*	Each	1194	5.97	
1030	Fittings	Toilet partitions		S.F. Floor	1.04	1.04	
2010	Stair Construction	Concrete filled metal pan		Flight	13,700	4.80	
3010	Wall Finishes	60% vinyl wall covering, 40% paint		S.F. Surface	1.49	1.19	
3020	Floor Finishes	60% carpet, 30% vinyl composition tile, 10% ceramic tile		S.F. Floor	8.33	8.33	
3030	Ceiling Finishes	Mineral fiber tile on concealed zee bars		S.F. Ceiling	6.86	6.86	
D. SERVICES							
	D10 Conveying						
1010	Elevators & Lifts	Two hydraulic passenger elevators		Each	125,600	12.56	9.1%
1020	Escalators & Moving Walks	N/A		—	—	—	
	D20 Plumbing						
2010	Plumbing Fixtures	Toilet and service fixtures, supply and drainage	*1 Fixture/1320 S.F. Floor*	Each	4884	3.70	3.4%
2020	Domestic Water Distribution	Gas fired water heater		S.F. Floor	.44	.44	
2040	Rain Water Drainage	Roof drains		S.F. Roof	1.86	.62	
	D30 HVAC						
3010	Energy Supply	N/A		—	—	—	12.1 %
3020	Heat Generating Systems	Included in D3050		—	—	—	
3030	Cooling Generating Systems	N/A		—	—	—	
3050	Terminal & Package Units	Multizone unit gas heating, electric cooling		S.F. Floor	16.75	16.75	
3090	Other HVAC Sys. & Equipment	N/A		—	—	—	
	D40 Fire Protection						
4010	Sprinklers	Wet pipe sprinkler system		S.F. Floor	3.82	3.82	3.4%
4020	Standpipes	Standpipes and hose systems		S.F. Floor	.91	.91	
	D50 Electrical						
5010	Electrical Service/Distribution	1000 ampere service, panel board and feeders		S.F. Floor	4.71	4.71	16.7%
5020	Lighting & Branch Wiring	High efficiency fluorescent fixtures, receptacles, switches, A.C. and misc. power		S.F. Floor	12.06	12.06	
5030	Communications & Security	Addressable alarm systems, internet and phone wiring, and emergency lighting		S.F. Floor	5.97	5.97	
5090	Other Electrical Systems	Emergency generator, 7.5 kW, uninterruptible power supply		S.F. Floor	.24	.24	
E. EQUIPMENT & FURNISHINGS							
1010	Commercial Equipment	N/A		—	—	—	0.0 %
1020	Institutional Equipment	N/A		—	—	—	
1030	Vehicular Equipment	N/A		—	—	—	
1090	Other Equipment	N/A		—	—	—	
F. SPECIAL CONSTRUCTION							
1020	Integrated Construction	N/A		—	—	—	0.0 %
1040	Special Facilities	N/A		—	—	—	
G. BUILDING SITEWORK		**N/A**					
					Sub-Total	137.98	**100%**
	CONTRACTOR FEES (General Requirements: 10%, Overhead: 5%, Profit: 10%)				*25%*	34.50	
	ARCHITECT FEES				*7%*	12.07	
					Total Building Cost	**184.55**	

177

Appendix C- Existing Conditions Plan and Phasing Plans



Existing Conditions Plan

Research Facility Core and Shell

September 21, 2012

Timothy Maffett

LEGEND

- New Building
- Temporary Facility
- Existing Building
- Portable Toilet
- Boundaries of Site
- Site Fence
- Fire Hydrant
- High Voltage Line
- Low Voltage Line
- Gas Line
- Water Line
- Vehicle Traffic
- Pedestrian Traffic

Building Excavation Plan

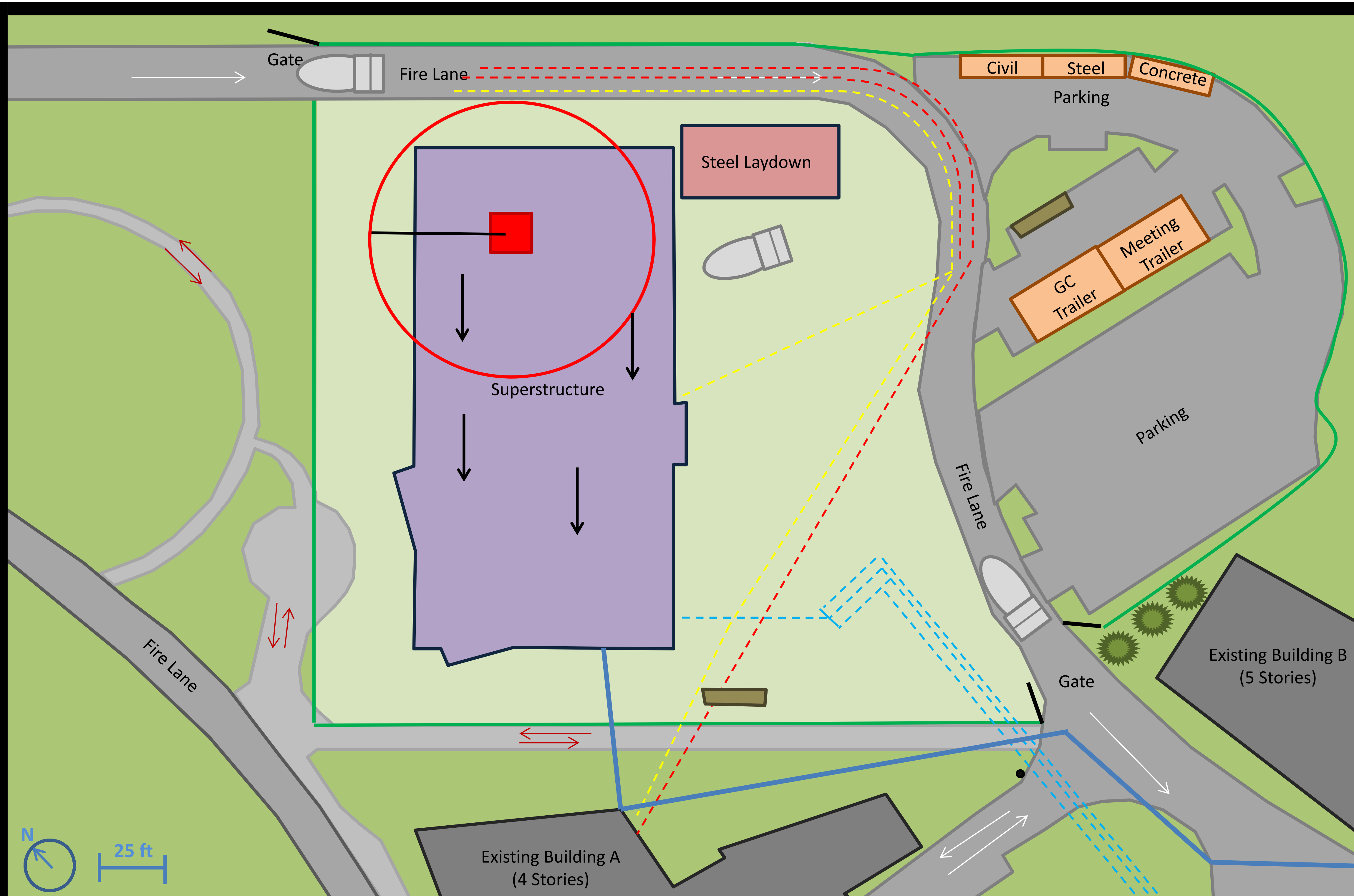
Research Facility Core and Shell

September 21, 2012

Timothy Maffett

LEGEND

Soil	Boundaries of Site
Temporary Facility	Site Fence
Existing Building	Fire Hydrant
Portable Toilet	
High Voltage Line	Vehicle Traffic
Low Voltage Line	Pedestrian Traffic
Gas Line	Dump Truck
Water Line	Excavator



Superstructure Logistics Plan

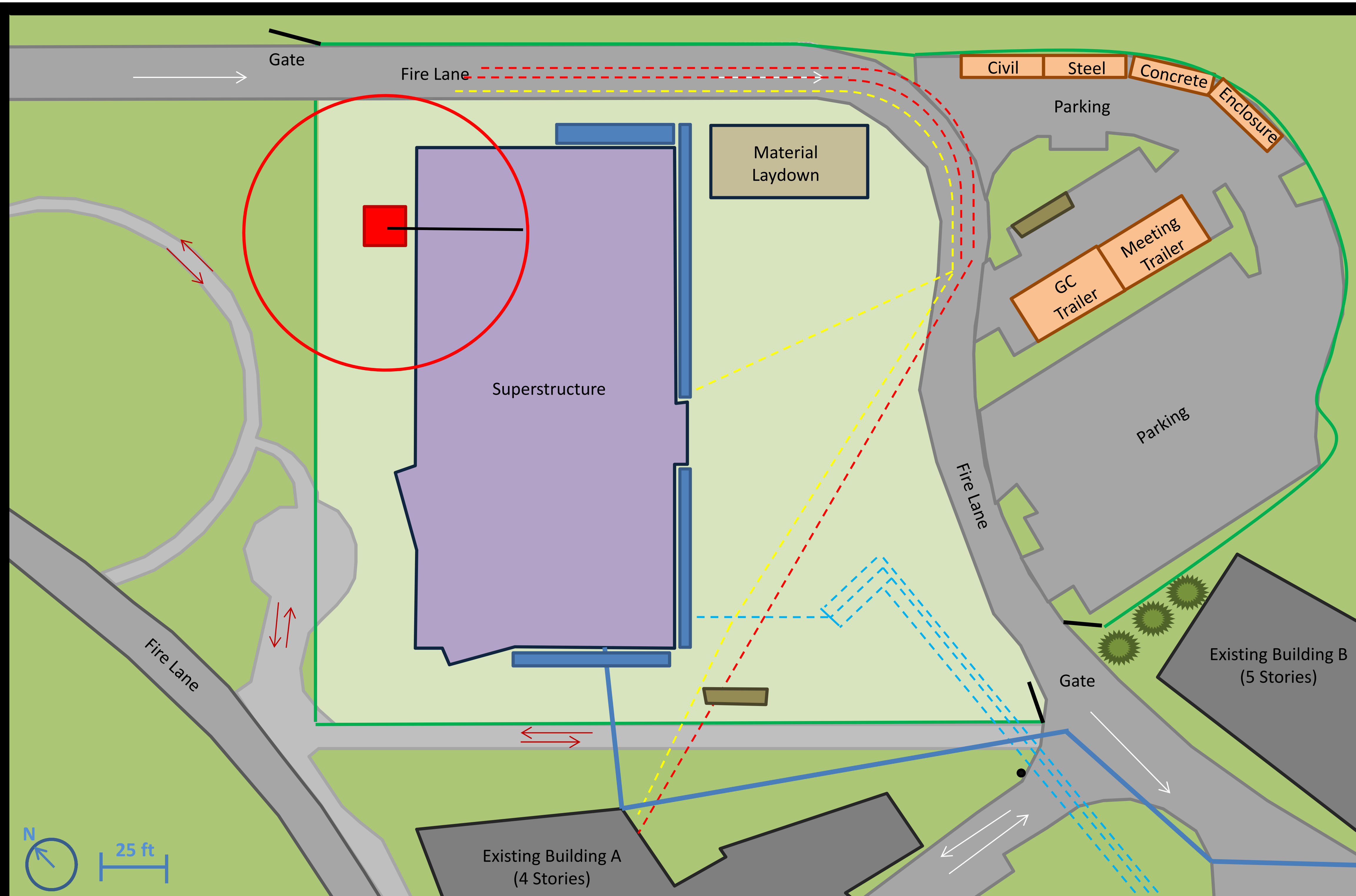
Research Facility Core and Shell

September 21, 2012

Timothy Maffett

LEGEND

- Superstructure
- Temporary Facility
- Existing Building
- Portable Toilet
- Boundaries of Site
- Site Fence
- Fire Hydrant
- Steel Laydown
- High Voltage Line
- Low Voltage Line
- Gas Line
- Water Line
- Vehicle Traffic
- Pedestrian Traffic
- Crane
- Concrete Truck



Building Enclosure Plan

Research Facility Core and Shell

September 21, 2012

Timothy Maffett

LEGEND

- Superstructure
- Temporary Facility
- Existing Building
- Portable Toilet
- Boundaries of Site
- Site Fence
- Fire Hydrant
- Material Laydown
- High Voltage Line
- Low Voltage Line
- Gas Line
- Water Line
- Vehicle Traffic
- Pedestrian Traffic
- Crane
- Scaffolding