TECHNICAL REPORT 1

C-5 Fuel Cell Facility

167th Airlift Wing

Martinsburg, WV

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Construction Management

October 5, 2009

Dr. Riley

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EXECUTIVE SUMMARY

The technical assignment which follows provides an introduction to the C-5 Fuel Cell Facility project for the 167th Airlift Wing in Martinsburg, WV. Included in this report are the basics of the construction management techniques used by Kinsley Construction, Inc. for completing this project, as well as the existing conditions of the project. A discussion on the purpose of the project and the expectations of the client for a successful project is also found in this report.

The C-5 Fuel Cell Facility is being constructed under a Design-Build contract between the 167th Airlift Wing of the West Virginia Air National Guard and Kinsley Construction, Inc. of York, PA. Under this agreement Kinsley Construction has management responsibilities for all design and construction activities. It is interesting to note that Kinsley Construction is acting not only as a construction manager for the project, but also as a general contractor, as they are self-performing a significant portion of the work. Further information about Kinsley Construction's management of construction for this project can be found in the following sections: *project schedule summary*; *project delivery system*; and *staffing plan*.

Some of the unique aspects of the Fuel Cell Facility are the structural steel system and the high expansion foam fire protection system. These systems will not be discussed in great detail in this report, but some basic information concerning the structural steel can be found in the *building systems summary*. The abnormality of the steel system is also expressed in the cost of the system as compared to the typical cost of a hangar. This difference can be seen in the *project cost evaluation* by comparing the actual estimated cost against the square foot estimate developed from RS Means data.

PROJECT SCHEDULE SUMMARY

The schedule for the Fuel Cell Facility is fairly straightforward as a Design-Build project. Unfortunately, one of the key advantages of the design-build delivery system was not fully realized; almost no time was saved in the schedule by overlapping the design and construction phases. In fact the design of the building, neglecting minor changes further into the project, was almost entirely finished before any major construction activities began. Fortunately, due to the somewhat decreased complexity of the project, specifically in the finishes area, the design phase for the Fuel Cell Facility was fairly short at only 98 days from time of award until the 100% Design Document Review. Official awarding of the project to Kinsley Construction occurred in early October of 2008 with a proposed project completion date at the end of March 2010.

FOUNDATIONS

Prior to any foundation construction, blasting of the rock on site was completed as well as mass excavation to meet the grade of the proposed building pad. The foundation sequence, which began near the end of April 2009 and ended near the end of June 2009, consisted of caissons, grade beams and pier caps, as well as a small section of strip footings.

Caisson being poured

Pier Cap after placing

STRUCTURAL SYSTEM

Structural steel erection began in mid-July following the completion of the foundation sequence and was completed near the end of August. The steel erection began on the west side of the building with the long transverse truss being set by two crawler cranes and then supported with temporary shoring towers. A third crawler crane also helped support the truss until the apex trusses were set to hold everything together. This sequence was repeated on the east side of the building as it mirrors the west side. Finally, the truss which spans over the main hangar door was set to connect the two sides. This truss was set in three sections, one by each of the three cranes. It too required the temporary shoring towers as support until the entire structure was complete.

Steel Erection

BUILDING ENCLOSURE

Following steel erection, roof construction and masonry work on the exterior walls began, with the installation of the insulated wall panels following immediately after the completion of the split-face CMU. Upon completion of these items as well as installation of the insulated translucent panels, the building exterior is mostly completed and construction of MEP systems as well as partition walls begins. The building will not be water tight though until late December 2009 when the hangar door is installed.

FINISHES

Due to the function of the Fuel Cell Facility, finishes in the building are limited. The walls are simply painted CMU and the floors are primarily exposed concrete, VCT, or ceramic tile. This sequence of activities occurs before the hangar door is installed so the building is not yet completely enclosed. Once the building has become water tight, the MEP systems will be completed along with the fire alarm and security systems running throughout the building. Exterior improvements such as asphalt roadways and miscellaneous concrete pads will begin in late October 2009 and be completed around the same time as the building becomes water tight. When all interior systems are near completion, preliminary testing will begin in preparation for the commissioning process which will take place in March 2010.

See Appendix A for Project Schedule

BUILDING SYSTEMS SUMMARY

Construction Activity	In Scope of Work?
Demolition	No
Support of Excavation	Yes
Structural Steel Frame	Yes
Cast In Place Concrete	Yes
Precast Concrete	No
Mechanical System	Yes
Electrical System	Yes
Masonry	Yes
Curtain Wall	Yes

SUPPORT OF EXCAVATION

- Steel casing used to support excavation of 3' and 6' diameter caissons
- Submersible pump used to dewater excavations for caissons

STRUCTURAL STEEL FRAME

- Braced frame with two transverse trusses spanning nearly 220 feet
- Wide flange and hollow structural steel columns and beams
- K-series and Long span joists supporting roof
- 3 crawler cranes (250 ton, 200 ton, 160 ton) following sequence of steel erection as described in schedule summary

CAST IN PLACE CONCRETE

- 3000 psi reinforced concrete used for caissons, grade beams, and pier caps
- 4000 psi reinforced concrete used for slab on grade
- Hand-set steel formwork used for grade beams, pier caps, and slab on grade
- Slab on grade design was changed based on under floor drainage system- had been broken into 75' x 75' squares with drains at center, now trench drains are used with floor sloping toward them

MECHANICAL SYSTEM

- (13) vented infrared radiant heaters providing 300MBH each to the hangar area are suspended from the structural steel
- (2) 15,000 CFM make-up air units which are located, one each, in the mechanical rooms provide ventilation to the hangar area along with inline centrifugal exhaust fans
- Centrifugal fans at 250 CFM aid in exhausting of trench drains under the floor slab
- HVAC for the support spaces is provided by two 300 GPM boilers, a 4,000 CFM air handling unit, three 1,400 CFM energy recovery units and VAV boxes
- A wet pipe automatic fire sprinkler system provides fire protection to all areas of the building
- A high expansion foam (HEF) system provides additional fire protection to the hangar area

ELECTRICAL SYSTEM

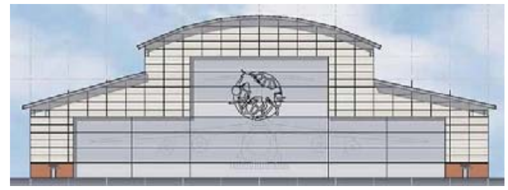
- A new service transformer will convert the 12.47 kV utility distribution to 480Y/277V building utilization
- 200A load break junction boxes distribute power to the building
- Connections are provided in the electrical room for 400Hz generators

MASONRY

- A split-face CMU veneer covers the first 10' above finished floor level around the exterior of the building with an accent course at approximately 3' above finished floor level.
    - The veneer is connected to the structural steel around most of the building.
    - Connections are made to a load-bearing CMU wall around parts of the support spaces.
- Load-bearing 12" CMU walls separate the hangar area from the support spaces and provide support for K-series joists with bearing plates at top of walls.
- CMU partition walls provide separation between support space rooms.
- Scaffolding for all CMU walls is simple birdcage type scaffold

CURTAIN WALL

- Above the masonry on the exterior, insulated metal wall panels cover the majority of the wall space.
- For the lower tiered portion of the building, the panels are set with the use of articulated boom lifts.
- The panels covering the higher tier will be set through the use of scaffolding which is set on the lower tier roof.



PROJECT COST EVALUATION

COST SUMMARY FOR C-5 FUEL CELL FACILITY

Construction Cost:	$23,551,204	$298.78 per SF

Note: Construction Cost includes all costs except sitework, permits, and design fees

Total Project Cost:	$26,757,781	$339.46 per SF

BUILDING SYSTEMS COSTS

Mechanical System:	$3,419,475	$43.38 per SF

Note: includes HVAC and fire sprinkler

Electrical System:	$1,706,783	$21.65 per SF
Steel:	$7,768,880	$98.56 per SF

Note: includes structural steel and misc. metals

Structural Concrete:	$1,598,316	$20.28 per SF

Note: includes foundations and slab on grade

Sitework:	$1,650,799	$20.94 per SF

Note: does not include building earthwork, that is included in Construction Cost

D4 COST ESTIMATE

With the D4 Cost Estimating Software, I created an estimate for the C-5 Fuel Cell Facility using historical cost data from the two projects listed below, and adjustments for time and location. The projects were chosen based on having a similar square footage to the Fuel Cell Facility as well as only having one story. Unfortunately, D4 did not have any aircraft hangars in its database so I had to select projects that seemed like they would have longer spans of steel as is the case in the Fuel Cell Facility. When the averaging wizard was used, D4 came up with an estimate of $243.09 per SF which works out to be a total of $19,161,862. This estimated value is approximately $7.6 million less than what was actually estimated from the drawings and specifications for the C-5 Fuel Cell Facility.

Galaxy 14 Cinema	73,342 SF	1 Floor	$8,328,276
Kansas City Auto Auction	67,000 SF	1 Floor	$3,732,973

See Appendix B for D4 Cost Estimate

RS MEANS SF ESTIMATE

To begin, the Aircraft Hangar was selected from the 2009 RS Means Square Foot Estimating book. The area of the Fuel Cell Facility fell within the range listed, so I was able to interpolate to find values corresponding to a Steel Frame with Metal Sandwich Panels as the exterior walls. The model in RS Means did not include any special foundations, such as the caissons on the Fuel Cell Facility, so I had to assume a cost per SF for these which I based off of the cost for the slab on grade. The hangar door in RS Means seemed to be rather small in comparison to the actual type of door system being utilized so I assumed that the actual cost would be close to double that of the SF cost listed. These additions were added to the base cost before the story height and perimeter adjustments were made.

Base Cost per SF with noted additions:	$111.85	
Story Height Adjustment:	$16.72	$0.44 per foot
Perimeter Adjustment:	$0.07	$1.06 per 100 lineal feet
Subtotal per SF:	**$128.64**	

$128.64/SF x 78,825SF = $10,140,048

Additives (speakers and security) $7389

$10,147,437 x 0.90(location factor) = <u>$9,132,693 Total Cost</u>

$9,132,693/ 78,825SF = $115.86 per SF

See Appendix C for RS Means information used

COMPARISONS

In the case of both D4 and RS Means, the cost per square foot is less than the actual construction cost for the C-5 Fuel Cell Facility. The D4 estimate was much closer to the actual with a difference of about $55 per SF, while the RS Means estimate was low by about 60%, or more than $180 per SF. Some of the reasons that these low numbers occurred, specifically with the RS Means estimate, may include the following:

- The hangar in RS Means is a very basic commercial hangar most likely for far smaller planes than the C-5 and therefore do not require nearly as large of spans for the steel, greatly reducing the sizes of members required.
- The model contains no cost for the High Expansion Foam system which is present in the Fuel Cell Facility.
- The Fuel Cell Facility also contains support spaces within the building which increases the cost of HVAC, electrical systems, and finishes.

SITE CONDITIONS

SITE LOCATION

- Project located at West Virginia Eastern Regional Airport in Martinsburg, WV
- Part of base for 167th Airlift Wing of West Virginia Air National Guard

NEIGHBORING STRUCTURES

- North- Access road into and out of the base
- East- Maintenance Hangar for C-5 aircraft; almost identical to the proposed Fuel Cell Facility
- South- Taxiway and runway for C-5 aircrafts
- West- Fire department for the Airlift Wing

SPECIAL CONDITIONS

- As a military base, access is restricted
- Security of the runway is of extreme importance- painted lines on concrete of taxiway denote that contractors may not cross
- After blasting procedures, a survey was required to check for any stones that may have flown on to the taxiway
- Dust from construction activities is required to be minimized for sake of operation of aircrafts at the airport- site needs to be watered down
- All structures at the airport need to be lit at night as well as flagged during the day- this includes the building itself as well as the cranes being used on site
- Construction activities can be stopped at any time by Contracting Officer when under a security warning

See Appendix D for Site Plans

Aerial view of project location

(Courtesy of Google Maps)

LOCAL CONDITIONS

PREFERRED METHODS OF CONSTRUCTION

The Martinsburg, WV region is one in which a particular structural system is not necessarily preferred over the other. That is, there are buildings with concrete structures as well as those with steel structures. For the Fuel Cell Facility though, it is obvious that a steel structural system is required due to the incredibly long spans that are required. Such a building could not be done as a concrete structure. All other parts of the project stay fairly close to the typical construction methods of the region such as slabs on grade and CMU exterior walls. The architectural features of the building, while not typical for any buildings outside of the base, match perfectly with the existing structures on the base.

CONSTRUCTION PARKING AVAILABILITY

The site for the Fuel Cell Facility is such that construction parking is very convenient. There is a large gravel covered area between the building footprint and the access road to the north which is used for job trailers, office trailers, and material laydown, as well as parking for the project.

RECYCLING AND TIPPING FEES

Disposal of all debris and construction waste is to be done off the base and is the responsibility of the contractor. The cost of this service is approximately $650 per month.

SOIL AND GROUNDWATER CONDITIONS

According to the Geotechnical Report, the subsurface stratification is divided into two strata: (1)residual soils with sands, silts and rock fragments, and (2)rock which is primarily shale. From the borings that were completed, it was found that the condition of the shale for bearing ranged from being very poor to good. It was suggested in the report that drilled shaft foundations be used in order to have bearing on competent rock, hence the use of caissons. The report also stated that no groundwater was found during the borings, but noted that it may become present depending on the fracture structure of the shale. This information was based on the construction of the Maintenance Hangar to the east of the Fuel Cell Facility; no groundwater was found during borings for that building, but it was encountered when holes for caissons were drilled. Submersible pumps were used to dewater the drilled holes for the caissons when necessary, but subsurface water was minimal.

CLIENT INFORMATION

The Owner and future occupant of the C-5 Fuel Cell Facility is the 167th Airlift Wing of the West Virginia Air National Guard. This unit is responsible for the flight and maintenance of the C-5 Galaxy aircraft as seen to the left. The Fuel Cell Facility is part of the overall C-5 Conversion project at the Martinsburg base which consists of major renovations to the West Virginia Eastern Regional Airport. Some of the other individual projects that have been completed as part of the Conversion project include complete reconstruction and expansion of the runways at the airport, construction of the Maintenance Hangar which is located to the immediate east of the Fuel Cell Facility, and a new control tower.

Cost expectations for this project are slightly different than private construction projects. As with all parts of the public sector, federal funding is set by a budget and the money must be spent or the budget will most likely be decreased in the future. Of course, this does not mean that there is unlimited funding and the project is still expected to be completed for budgeted cost. Completion of the project by the scheduled date is of importance to the owner mainly because of a desire to occupy the building as soon as possible. While the owner is not looking to make a profit from the final product as in commercial projects, the completion of this building means that the overall Conversion project is one step closer to being complete. Also, there are no plans for any phased occupancy of the building, so the Airlift Wing cannot move in to the building until completion.

Safety is of utmost importance to the Owner but has not been an issue thus far on the Fuel Cell Facility project. This is due in large part to the safety program in place by Kinsley Construction which includes training of all individuals who are to work on the site, as well as safety inspections by company safety officials. The Contracting Officer, a Lt. Col. in the Airlift Wing, has discussed some of the discrepancies he has had in the past with contractors concerning safety issues, and expressed that he has no problems with kicking somebody off the site for violations.

With regards to the quality of the project, the Lt. Col. has also repeatedly explained, through examples of the two similar hangars on the base, what he expects from the Fuel Cell Facility. While there are no high-end finishes in the hangar, the details that are present are expected to be just right. One item that has been specifically addressed is the jointing in the slab for the hangar area. The Lt. Col. has shown the two existing hangars and specified the parts in each that he likes best.

The only sequencing issue that the Owner has shown concern for is the steel erection as the project completion is mainly driven by the completion of the structural frame.

PROJECT DELIVERY SYSTEM

- 167th Airlift Wing — WV Air National Guard — Owner
  - Kinsley Construction, Inc. — Design/Build Manager
    - LSC Design — Design Project Manager, Architect
      - TranSystems — Structural Engineer
      - TranSystems — MEP Engineer
      - Greenway Engineering — Civil Engineer
    - Kinsley Construction, Inc. — Sitework Contractor
    - Kinsley Construction, Inc. — Structural Steel Fabricator/Erector
    - Ralph E. Tolbert Masonry — Masonry Contractor
    - Megadoor — Hangar Door Contractor
    - James Craft & Son — Mechanical Contractor
    - I.B. Abel — Electrical Contractor
    - VFP Fire Systems — Fire Sprinkler Contractor

Note: All contracts are Lump Sum contracts.

PROJECT DELIVERY SYSTEM

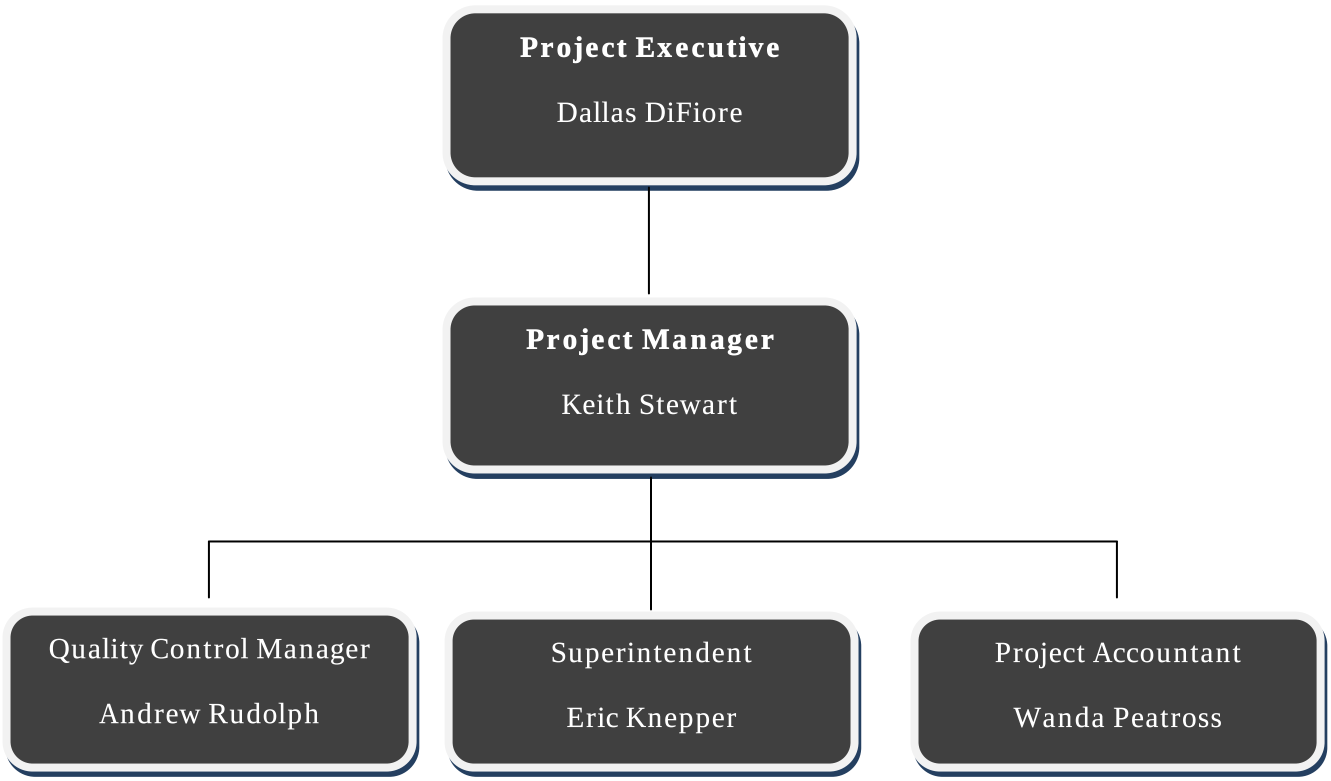
The C-5 Fuel Cell Facility project has a unique organizational structure, as seen in the chart above. This abnormal structure has been used because a design-build delivery system was chosen for this project. The decision to use this project delivery method was determined based on the requirements of the funding for the project. As a federally funded project, the government was able to be selective in how this project was delivered. In some cases, this would cause projects to be bid as small business set-asides, but due to the size of this project that was not an option and so the design-build was the second option.

Kinsley Construction was selected to be the Design-Build Contractor and Project Manager based on a Lump Sum bid which was created from the preliminary project documents provided in the Request for Proposal. Acting as the Design-Build Manager and a general contractor, Kinsley was required to provide payment and performance bonds for the total value of the project. Kinsley Construction was also required to purchase Builder’s Risk Insurance.

LSC Design was selected as the Design Project Manager for the project as it is an entity in the Kinsley family of companies. The contract between Kinsley and LSC is set up as a subcontract though, as are all of the contracts between LSC and the engineering firms that were selected. All of these contracts are based on a lump sum as noted above in the organizational chart. Subcontractors were selected based on lump sum bids to Kinsley Construction for the project and therefore the contracts are based on those lump sums. It can be seen in the organizational chart that Kinsley Construction opted to self-perform the sitework as well as the steel fabrication and erection.

Although the decision to use the design-build project delivery system was set by the circumstances of the funding, it is to the advantage of the Owner to use this. With this type of project delivery, the Owner needs to be responsible for only one contract, allowing all other responsibilities to be taken care of by the Design-Build Manager. It also creates much greater collaboration between contractors and design professions which can help eliminate problems further down the road that occur frequently with the design-bid-build method.

STAFFING PLAN



The Project Executive's role in the project is to oversee the project as a whole and was primarily involved during the design phase of the project by coordinating with the Design Project Manager. He spends most of his time away from the site as he is also involved with other projects currently being worked on by the company. The Project Manager spends much more time on site and his duties include: cost control; working with the safety director; coordination with the Superintendent about manpower and materials; managing contractual arrangements with subcontractors; maintaining good working relations between Owner, Contractor, and Designer. The Project Manager also oversees all tasks completed by the QCM, Superintendent, and the Accountant relevant to the project.

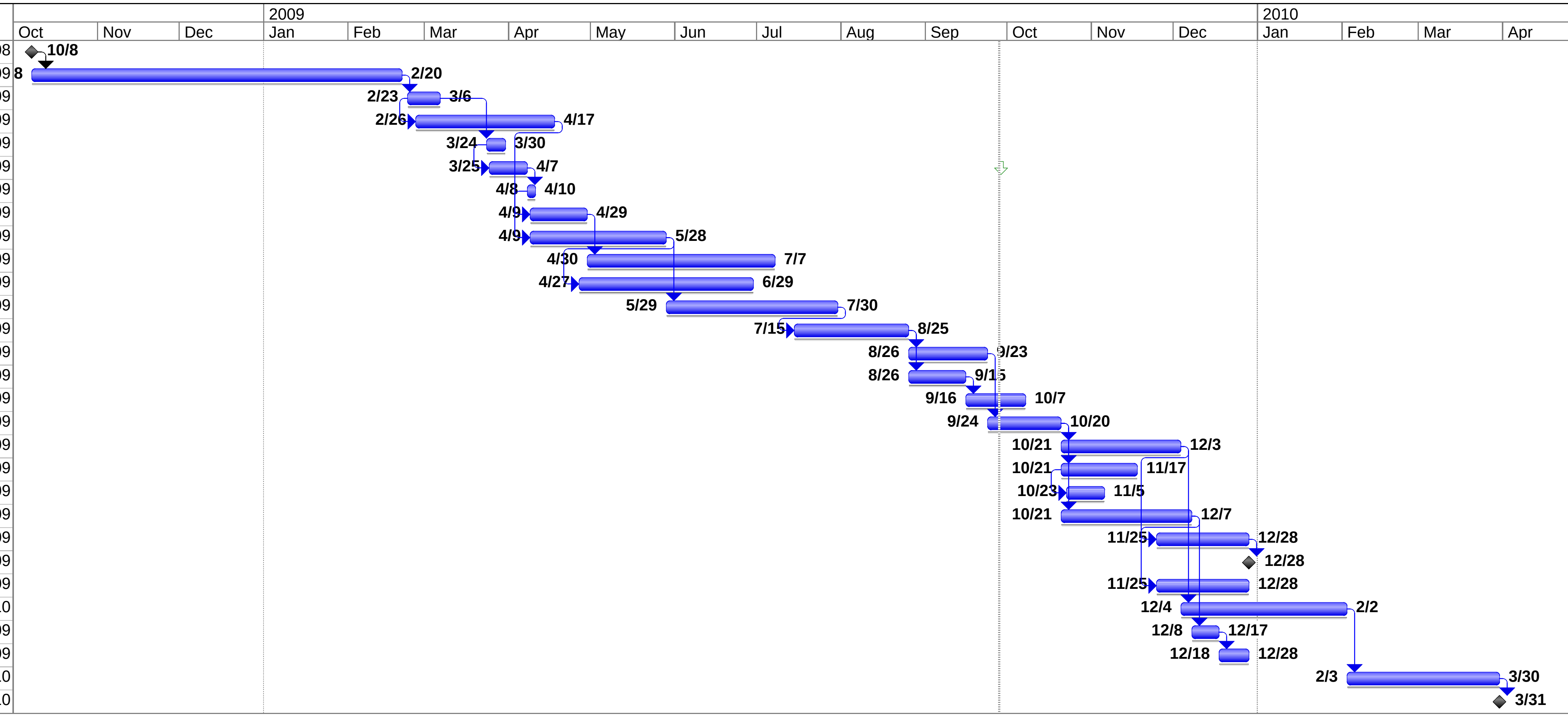
The Quality Control Manager is on the site at all times and is responsible for the following: inspection of work put in place for compliance with design documents; reporting any deficiencies; field correspondence; review of plans and specifications for accuracy. Management of on-site activities is the responsibility of the Superintendent. He is in charge of: ordering and scheduling material deliveries; assigning crews; monitoring the deficiencies list created by the QCM; enforcing security on the site. The Project Accountant is responsible for tracking all costs and expenditures for the project.

Appendix A

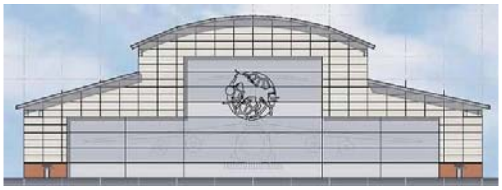
C-5 Fuel Cell Facility

Project Schedule Summary

ID	Task Name	Duration	Start	Finish
1	Notice to Proceed	0 days	Wed 10/8/08	Wed 10/8/08
2	Design Phase	98 days	Wed 10/8/08	Fri 2/20/09
3	100% Design Document Review	10 days	Mon 2/23/09	Fri 3/6/09
4	Structural Shop Drawings	37 days	Thu 2/26/09	Fri 4/17/09
5	Office Mobilization	5 days	Tue 3/24/09	Mon 3/30/09
6	Issue Construction Documents	10 days	Wed 3/25/09	Tue 4/7/09
7	Initial Layout and Stakeout	3 days	Wed 4/8/09	Fri 4/10/09
8	Approve Structural Shop Dwgs	15 days	Thu 4/9/09	Wed 4/29/09
9	Site-Stormwater and Grading for Bldg	36 days	Thu 4/9/09	Thu 5/28/09
10	Fabricate Structural Steel and Joists	49 days	Thu 4/30/09	Tue 7/7/09
11	Construct Foundations	46 days	Mon 4/27/09	Mon 6/29/09
12	Underground Utilities	45 days	Fri 5/29/09	Thu 7/30/09
13	Steel Erection	30 days	Wed 7/15/09	Tue 8/25/09
14	Construct Roof	21 days	Wed 8/26/09	Wed 9/23/09
15	Masonry Walls	15 days	Wed 8/26/09	Tue 9/15/09
16	Install Insulated Metal Panels	16 days	Wed 9/16/09	Wed 10/7/09
17	Floor Slab	19 days	Thu 9/24/09	Tue 10/20/09
18	MEP Rough-In Overhead	32 days	Wed 10/21/09	Thu 12/3/09
19	Construct Interior Partition Walls	20 days	Wed 10/21/09	Tue 11/17/09
20	MEP Rough-In in Walls	10 days	Fri 10/23/09	Thu 11/5/09
21	Site Asphalt and Concrete	34 days	Wed 10/21/09	Mon 12/7/09
22	Install Hangar Door	24 days	Wed 11/25/09	Mon 12/28/09
23	Building Enclosed	0 days	Mon 12/28/09	Mon 12/28/09
24	Complete MEP Systems	24 days	Wed 11/25/09	Mon 12/28/09
25	Fire Alarm and Security System	43 days	Fri 12/4/09	Tue 2/2/10
26	Complete Sevice Road- Wearing and Paint	8 days	Tue 12/8/09	Thu 12/17/09
27	Landscaping	7 days	Fri 12/18/09	Mon 12/28/09
28	Testing and Commissioning	40 days	Wed 2/3/10	Tue 3/30/10
29	Project Complete	0 days	Wed 3/31/10	Wed 3/31/10



Project: C-5 Summary Schedule.mpp Date: Mon 9/28/09	Task		Milestone	◆	Rolled Up Task		Rolled Up Progress		External Tasks		Group By Summary	
	Progress		Summary		Rolled Up Milestone	◇	Split		Project Summary		Deadline	⇩



Appendix B

C-5 Fuel Cell Facility

D4 Cost Estimate

Statement of Probable Cost

C-5 Fuel Cell Facility - Jul 2009 - WV - Other

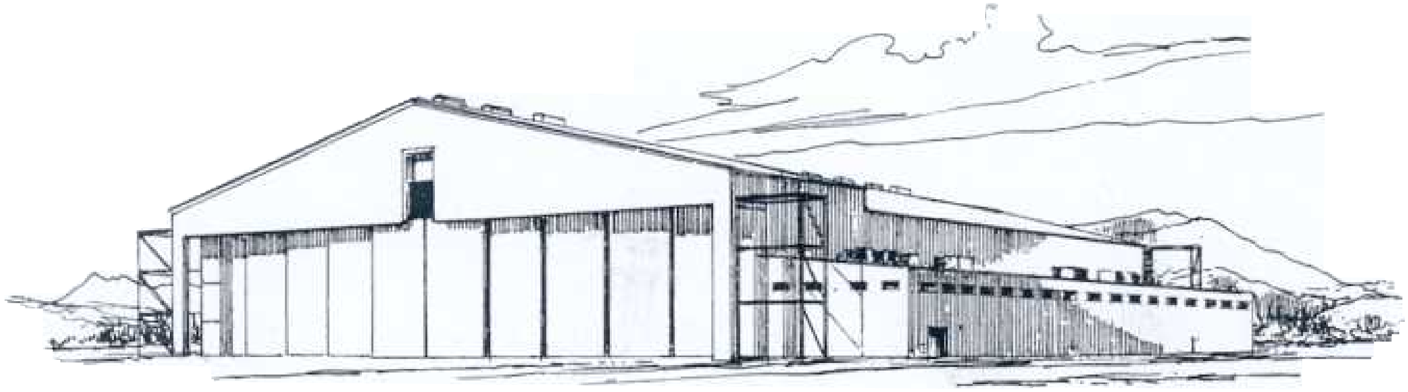
Prepared By:	Kyle Goodyear AE Senior Thesis 2010 The Pennsylvania State University University Park, PA 16802 717-887-9125 Fax:	Prepared For:	AE Department The Pennsylvania State University 104 Eng. Unit A University Park, PA 16802 Fax:
Building Sq. Size:	78825	Site Sq. Size:	51732
Bid Date:		Building use:	Civic/Gov.
No. of floors:	1	Foundation:	CAS
No. of buildings:	1	Exterior Walls:	MET
Project Height:		Interior Walls:	CMU
1st Floor Height:		Roof Type:	MET
1st Floor Size:		Floor Type:	CON
		Project Type:	NEW

Division		Percent	Sq. Cost	Amount
	Bidding Requirements			
	Bidding Requirements			
	General Requirements	**0.37**	**0.90**	**71,306**
	General Requirements	0.37	0.90	71,306
	Site Work	**6.47**	**15.73**	**1,239,880**
	Site Work	6.47	15.73	1,239,880
	Concrete	**6.98**	**16.97**	**1,337,637**
	Concrete	6.98	16.97	1,337,637
04	**Masonry**	**1.81**	**4.39**	**346,010**
	Masonry	1.81	4.39	346,010
	Metals	**10.29**	**25.01**	**1,971,591**
	Metals	10.29	25.01	1,971,591
06	**Wood & Plastics**	**7.62**	**18.53**	**1,460,431**
	Wood & Plastics	7.62	18.53	1,460,431
07	**Thermal & Moisture Protection**	**7.31**	**17.77**	**1,400,968**
	Thermal & Moisture Protection	7.31	17.77	1,400,968
08	**Doors & Windows**	**4.16**	**10.10**	**796,176**
	Doors & Windows	4.16	10.10	796,176
09	**Finishes**	**10.97**	**26.66**	**2,101,195**
	Finishes	10.97	26.66	2,101,195
10	**Specialties**	**3.66**	**8.91**	**702,052**
	Specialties	3.66	8.91	702,052
11	**Equipment**	**3.41**	**8.29**	**653,398**
	Equipment	3.41	8.29	653,398
12	**Furnishings**	**0.17**	**0.42**	**32,791**
	Furnishings	0.17	0.42	32,791
13	**Special Construction**	**3.51**	**8.52**	**671,827**
	Special Construction	3.51	8.52	671,827
14	**Conveying Systems**	**1.79**	**4.36**	**343,298**
	Conveying Systems	1.79	4.36	343,298
	Mechanical	**12.24**	**29.77**	**2,346,264**
	Mechanical	12.24	29.77	2,346,264
16	**Electrical**	**10.34**	**25.13**	**1,981,020**
	Electrical	10.34	25.13	1,981,020
Total Building Costs		100.00	243.09	19,161,862

Appendix C

C-5 Fuel Cell Facility

2009 RS Means Square Foot Estimate



Costs per square foot of floor area

Exterior Wall	S.F. Area	5000	10000	15000	20000	30000	40000	50000	75000	100000
	L.F. Perimeter	300	410	500	580	710	830	930	1150	1300
Concrete Block Reinforced	Steel Frame	130.55	115.00	108.75	105.20	100.85	98.45	96.70	94.00	92.10
	Bearing Walls	138.75	122.90	116.60	113.00	108.50	106.15	104.35	101.60	99.70
Precast Concrete	Steel Frame	150.05	128.35	119.65	114.65	108.55	105.25	102.75	99.00	96.30
	Bearing Walls	157.60	135.85	127.15	122.15	116.05	112.75	110.25	106.50	103.80
Galv. Steel Siding	Steel Frame	131.20	115.45	109.10	105.50	101.05	98.65	96.85	94.15	92.20
Metal Sandwich Panel	Steel Frame	136.90	119.35	112.30	108.30	103.35	100.65	98.70	95.65	93.50
Perimeter Adj., Add or Deduct	Per 100 L.F.	16.35	8.20	5.50	4.10	2.75	2.05	1.60	1.10	0.85
Story Hgt. Adj., Add or Deduct	Per 1 Ft.	1.60	1.10	0.90	0.80	0.65	0.60	0.55	0.45	0.40
Basement—Not Applicable										

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 $41.95 to $191.20 per S.F.

Common additives

Description	Unit	$ Cost
Closed Circuit Surveillance, One station		
Camera and monitor	Each	1850
For additional camera stations, add	Each	1000
Emergency Lighting, 25 watt, battery operated		
Lead battery	Each	282
Nickel cadmium	Each	805
Lockers, Steel, single tier, 60" or 72"	Opening	191 - 310
2 tier, 60" or 72" total	Opening	107 - 141
5 tier, box lockers	Opening	65 - 83.50
Locker bench, lam. maple top only	L.F.	21
Pedestals, steel pipe	Each	63.50
Safe, Office type, 1 hour rating		
30" x 18" x 18"	Each	2400
60" x 36" x 18", double door	Each	8750
Sound System		
Amplifier, 250 watts	Each	2350
Speaker, ceiling or wall	Each	191
Trumpet	Each	365

Location Factors

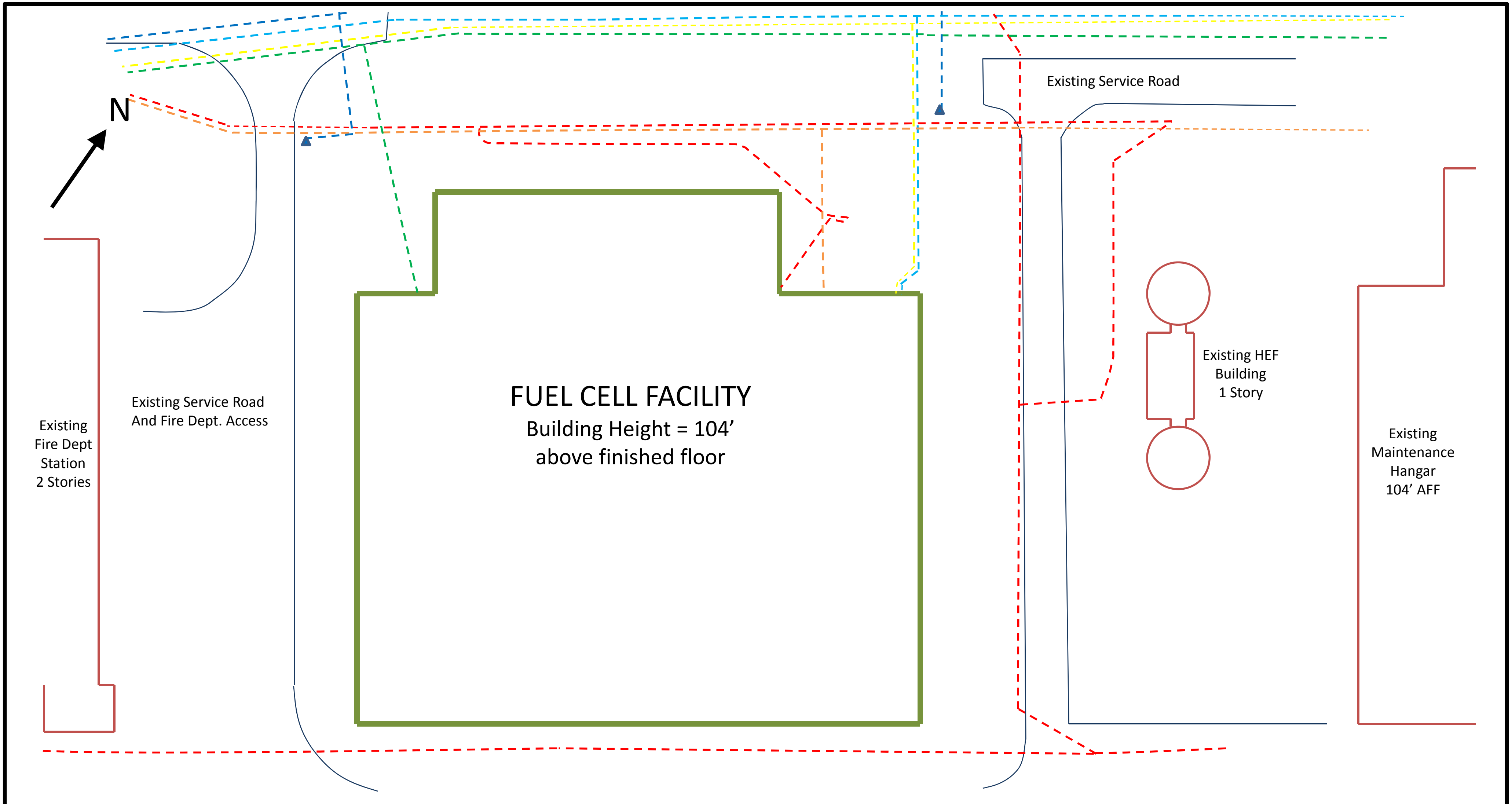
STATE/ZIP	CITY	Residential	Commercial
UTAH (CONT'd)			
845	Price	.70	.78
846-847	Provo	.80	.87
VERMONT			
050	White River Jct.	.76	.80
051	Bellows Falls	.78	.82
052	Bennington	.80	.83
053	Brattleboro	.80	.84
054	Burlington	.81	.86
056	Montpelier	.82	.84
057	Rutland	.81	.85
058	St. Johnsbury	.78	.80
059	Guildhall	.77	.79
VIRGINIA			
220-221	Fairfax	1.02	.93
222	Arlington	1.03	.93
223	Alexandria	1.07	.95
224-225	Fredericksburg	.94	.88
226	Winchester	.91	.86
227	Culpeper	.99	.88
228	Harrisonburg	.89	.86
229	Charlottesville	.90	.86
230-232	Richmond	.98	.88
233-235	Norfolk	1.00	.89
236	Newport News	.99	.88
237	Portsmouth	.92	.86
238	Petersburg	.96	.87
239	Farmville	.88	.81
240-241	Roanoke	.97	.85
242	Bristol	.85	.81
243	Pulaski	.83	.80
244	Staunton	.90	.84
245	Lynchburg	.95	.86
246	Grundy	.83	.80
WASHINGTON			
980-981,987	Seattle	1.02	1.04
982	Everett	1.04	1.02
983-984	Tacoma	1.02	1.03
985	Olympia	1.01	1.02
986	Vancouver	.97	1.01
988	Wenatchee	.92	.95
989	Yakima	.96	.98
990-992	Spokane	.99	.95
993	Richland	.97	.96
994	Clarkston	.96	.94
WEST VIRGINIA			
247-248	Bluefield	.88	.89
249	Lewisburg	.90	.92
250-253	Charleston	.95	.95
254	Martinsburg	.86	.90
255-257	Huntington	.96	.96
258-259	Beckley	.90	.93
260	Wheeling	.92	.96
261	Parkersburg	.91	.95
262	Buckhannon	.91	.95
263-264	Clarksburg	.91	.95
265	Morgantown	.92	.95
266	Gassaway	.91	.95
267	Romney	.89	.92
268	Petersburg	.91	.93
WISCONSIN			
530,532	Milwaukee	1.07	1.03
531	Kenosha	1.03	1.00
534	Racine	1.02	1.00
535	Beloit	.98	.97
537	Madison	.98	.98
538	Lancaster	.97	.94
539	Portage	.96	.95
540	New Richmond	.99	.95
541-543	Green Bay	1.00	.96
544	Wausau	.94	.92
545	Rhinelander	.94	.94
546	La Crosse	.94	.94
547	Eau Claire	.97	.95
548	Superior	.98	.96
549	Oshkosh	.94	.93
WYOMING			
820	Cheyenne	.82	.86
821	Yellowstone Nat. Pk.	.74	.81
822	Wheatland	.74	.82

STATE/ZIP	CITY	Residential	Commercial
WYOMING (CONT'd)			
823	Rawlins	.75	.83
824	Worland	.74	.81
825	Riverton	.73	.81
826	Casper	.76	.83
827	Newcastle	.74	.81
828	Sheridan	.79	.84
829-831	Rock Springs	.78	.83
CANADIAN FACTORS (reflect Canadian currency)			
ALBERTA			
	Calgary	1.14	1.14
	Edmonton	1.13	1.14
	Fort McMurray	1.14	1.13
	Lethbridge	1.11	1.09
	Lloydminster	1.06	1.05
	Medicine Hat	1.07	1.05
	Red Deer	1.07	1.05
BRITISH COLUMBIA			
	Kamloops	1.05	1.06
	Prince George	1.05	1.07
	Vancouver	1.06	1.11
	Victoria	.99	1.02
MANITOBA			
	Brandon	1.02	1.00
	Portage la Prairie	1.02	.99
	Winnipeg	1.02	1.04
NEW BRUNSWICK			
	Bathurst	.94	.95
	Dalhousie	.94	.95
	Fredericton	1.01	.98
	Moncton	.95	.96
	Newcastle	.94	.95
	St. John	1.01	.98
NEWFOUNDLAND			
	Corner Brook	.96	.98
	St. Johns	.98	.99
NORTHWEST TERRITORIES			
	Yellowknife	1.07	1.06
NOVA SCOTIA			
	Bridgewater	.97	.99
	Dartmouth	.98	1.00
	Halifax	1.00	1.02
	New Glasgow	.97	.99
	Sydney	.96	.97
	Truro	.97	.99
	Yarmouth	.97	.99
ONTARIO			
	Barrie	1.13	1.08
	Brantford	1.14	1.09
	Cornwall	1.14	1.08
	Hamilton	1.16	1.12
	Kingston	1.14	1.09
	Kitchener	1.09	1.05
	London	1.14	1.10
	North Bay	1.11	1.07
	Oshawa	1.13	1.08
	Ottawa	1.16	1.11
	Owen Sound	1.11	1.08
	Peterborough	1.12	1.08
	Sarnia	1.14	1.09
	Sault Ste Marie	1.07	1.04
	St. Catharines	1.10	1.05
	Sudbury	1.07	1.04
	Thunder Bay	1.12	1.05
	Timmins	1.11	1.07
	Toronto	1.17	1.14
	Windsor	1.11	1.05
PRINCE EDWARD ISLAND			
	Charlottetown	.92	.95
	Summerside	.92	.95
QUEBEC			
	Cap-de-la-Madeleine	1.13	1.04
	Charlesbourg	1.13	1.04
	Chicoutimi	1.16	1.05
	Gatineau	1.12	1.03

Appendix D

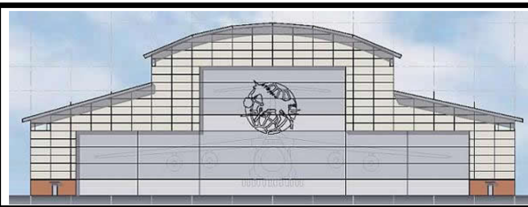
C-5 Fuel Cell Facility

Site Plans of Existing Conditions



C-5 Fuel Cell Facility
Martinsburg, WV
Kyle Goodyear
Construction Management

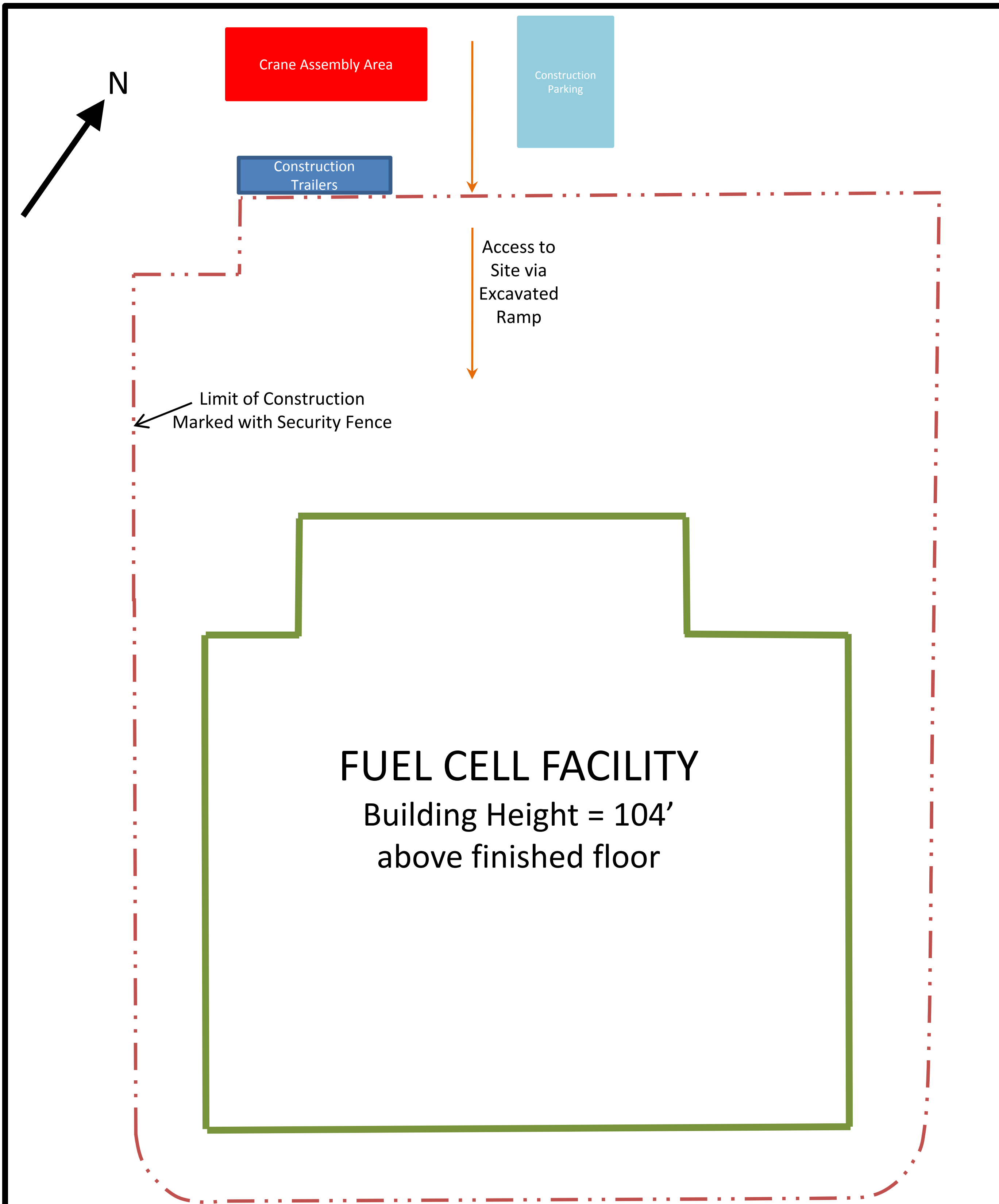
October 1, 2009



Gas
Water
Electric
Communications
Fire Line
Sanitary
Fire Hydrant

Site Utilities Plan

NTS



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Site Layout Plan
NTS