2011

Penn State AE Senior Thesis

The West Fuala Expansion

Abu Dhabi, PA

Technical Report 1

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Executive summary:

This Technical report would outline the main features of this project such as systems used, costs and project teams of the West Fuala plant expansion. This project is an expansion of the original facility which is over a century years old; the expansion will cover an area of 324,403 SF. The Eastern side will be attached to the old facility where there will be an open area between the two structures. The old structure would eventually become an office building while the new facility will take the role of production of this plant.

The building phase started on the January 2010 and is planned to be completed on Feb 2012 where it will production will begin as soon as the building is completed. The building consists of a basement along the southern side of the building, a first floor plan with an area of 207,765 SF and a mezzanine within the enclosed building with an area of 40,286 SF. The basement will have an overall concrete structure while the first floor would be an overall precast system. The mezzanine will be supported on the first floor's precast wall using steel HSS beams which would run along the western wall of the old facility and overlooking the first floor below from the western side. This will be explained more in building systems summary.

A project schedule summary is shown which depicts the major steps and phases in the construction process. This will briefly show the order and time in which major events will take place in this project. A project cost evaluation was done to compare the actual cost of the project with an RS means Square Foot estimate in addition to an Assembly estimate for the MEP system. It will also show a breakdown of the costs of each system.

Site Plans have been produced such as an Existing condition Plan which will show the site plan and the external factors that may affect the construction in addition to the main plan that will be conducted to complete the project. Moreover, Site Layout Plans are also included which will illustrate how the three main phases; Excavation, Superstructure and Finishing; will take place in the site.

Finally, the purpose of this report is to be a stepping stone to show how the project will launch and how it will take place in time, space, expectations and costs according to the client, General contractor and anyone that could be affected by this project. More information and details will be shown in the second technical repot.

Project Schedule Summary

The project schedule is basically as shown on the grant chat shown in Appendix A1 which illustrates the major phases of construction starting from obtaining the permit until substantial completion. However, since the project is an expansion of an existing plant which runs 24/7, there were a lot of requirements, issues and conditions that had to be done and maintained throughout the project which dictated the flow of the project schedule and caused major changes in the schedule. The Project schedule that is shown in Appendix A1 refers to the bid schedule and not the current schedule, and since it has been modified and changes are still taking place; the bid schedule would give a good description on what the project schedule is actually like less the date changes. Maintaining operating plant access, employee entrances, roadways and so on had to be taken into account in planning all of the site improvements to minimize the impacts to daily operations.

Foundation/ Sitework Sequence:

The first step in the foundation sequencing plan was to relocate Truck staging to an area to the east of the plant's boundaries right next to the old parking lot. After which, new access roads would be created in addition to a new parking lot and a stone construction support area. With that being done, excavation and foundation work can start. Site topography dictated that the basement and the new access road be excavated to provide fill material for the building footprint. In addition, the deep excavation at the basement and near the new plant entrance required rock blasting.

Building Erection Sequence:

Initial building construction as envisioned to run from south to north starting with the Basement {A-E, E-H.9, H.9-P then P-Q}. Due to cost consideration the north wall of the basement was not designed as a retaining wall. Consequently, they had to erect the entire south section of the building (A-E) from Basement to the roof, with cranes working on the south and north sides of the footprint. Cranes working on the north side of the basement precluded them from installing foundations just north of the basement. Rather than incur the downtime to install foundations (with curing) and the geo-grid backfill assembly in this area, they altered the construction sequence to run {A-E, Q-P, P-H.9 then H.9-E}.

To recoup some schedule time lost during preconstruction (due to the changes in scope), the precast erection was bought utilizing (2) cranes to cut their installation schedule from 22 weeks to 12 weeks. While the basement area (A-E) was erected from outside the footprint, the area (E-Q) was erected from inside the footprint. Their erection sequence (and requirements for crane roads / delivery access, etc) drove the installation of the Underslab plumbing and foundation concrete work for this area (E-Q).

Finishing sequence:

Finishing in this project refers to bringing in the plant equipment; and this will occur as soon as the building envelope is constructed and completed. There is no directional sequencing for the finishing stage as some things will be installed and finished before others. It depends on the location and the strategy on how to bring in the equipment. For instance, to facilitate easier installation of Fuala's large ingredient silos this area of the building and the adjoining Rail Receiving areas were changed from a precast concrete structure/walls to steel, metal deck and insulated metal panel walls. So rather than having this area erected 1st (in the south to north approach), the Silo and Rail areas are being completed last after equipment installation. This seriously complicated the installation of overhead MEP rough-in above the silos, requiring scaffolding to be erected over the entire area which has delayed completion of work close to a month.

Building Systems Summary

Scope of Work	Yes	No
Demolition	X	
Structural Steel Frame	X	
Cast in Place Concrete	X	
Precast Concrete	X	
Mechanical System	X	
Electrical System	X	
Masonry		X
Curtain Wall		X
Support of Excavation	X	

Demolition and site work:

The West plant expansion does not have major demolition phases. Basically, the parking to the east of the plant has to be removed and done once again in order to comply with new requirements and codes. Otherwise, the rest of the work before excavation was due to building new access roads, Plantation, open spaced area to support the construction phase and create a new parking lot to the west of the plant.

Structural Steel Fame:

The west plant expansion does not have any steel structural frame for the main building envelope; the only area where structural steel is used is within the building for the mezzanine. Most of the structural steel is used in the main mezzanine in area's F, D, B. The other area where the hollow structural section is used is along the mezzanine elevated pathway from O to B in addition to smaller mezzanine area all around the plant. The mezzanine is held up by attaching the hollow structural section to the precast walls of the building envelope. The Hollow structural sections run along the west-east direction in addition to the frame around the mezzanine.

Cast in Place Concrete:

Cast in Place concrete has been used moderately throughout the building. Starting from bottom to top, the basement has a cast in place foundations and walls all around in addition to cast in place slab on grade. The Mezzanine is also a slab on grade on metal deck, which is held by the Hollow structural section as mentioned earlier in the structural steel frame section. The SOG for the foundation is placed on top of the crushed stone base. All CIP concrete is to be air entrained with 4000psi at 28 days. Concrete will be pumped using pump trucks.

Precast Concrete:

The building envelope consists on precast panel walls all around the west plant expansion including the eastern wall that connects the new addition to the old plant. The basement is supported by mostly by 24x24 precast concrete columns in addition to other sizes. Those precast column hold the first floor which is also a precast concrete structure that has 4" reinforced topping slab. 24x24 precast concrete columns are also used in the first floor to hold the structure and the roof. The precast columns and walls on the first floor support the mezzanine steel structure. The roof is a precast concrete T beams below the EPDM with insulation.

Mechanical System:

The mechanical system is placed in the southwestern part of the building (Area I) in the basement level of the west plant on a raised concrete pad. The overall HVAC system will feature a total of 32 VAV reheat units serving the entire west plant providing air at 180F. The reheat system ranges from 150 CFM up to 2400 CFM. The Cooling systems will be placed on the roof and will supply air at 42 F. There are 13 air handling units placed on the roof and 2 air handling exchangers.

Electrical System:

A new utility building will be created along with the new west plant expansion. This utility will have a new 69KV feeder along with the original 69KV feeder; this will generate a total of 1200 Amps (600 from each) that will feed into the plant from PPL. The 2 service entrances will be feeding 4 substations through distribution panels running a 3phase (4-wire) 277/480V circuit. In addition, each substation will have 2 backup generators running at 450KW – 562.5KVA.

As for the lighting systems, the entire building will have florescent lighting all over. They are all consistent and are uniform throughout the plant from the basement and up to the mezzanine. The fixtures will be T8 lamps and electronic ballasts. In addition, there are 2 back generators at each of the 4 substations that will activate upon loss of power.

Support of Excavation:

Since the information was not found in the civil drawings. The following is an assumption of what could be the support of excavation until further verification is done.
As for the support for the excavation, shoring will be used to keep the excavated area in place after which the foundation phase should begin. Underpinning of the existing structure would also be done with extra care and support to hold the existing plant and prevent it from collapsing. In addition, if dewater would be required, standby pumps would be used to complete the task although no problem has been reported regarding the dewatering system.

Project Cost Evaluations:

The following section will show different types of estimates and how they differ from the actual costs. In addition, a breakdown of the cost relative to each trade will be shown.

Table 1 : Gross Building Area by Floor	
Basement	76,353 SF
1st Floor	207,765 SF
Mezzanine	40,285 SF
TOTAL	324,403 SF

Table 2: Basic Overall Cost Information				
Type	**Original Estimate**		**Current Estimate**	
	Cost ($)	Cost/SF ($/SF)	Cost ($)	Cost/SF ($/SF)
Construction Cost (CC)	$35,110,000	$108.23	$56,481,000	$174.11
Total Cost (TC)	$53,657,000	$165.40	$83,166,000	$255.85

As a result of drastic changes in the scope of work, the overall building cost and cost per square foot has increased as it can be seen in Table 2.

Table 3: Major Building Trades' Cost	
Trade Name	**Trade Cost ($k)**
General Condition	$12,681
Sitework/site utilities	$8,334
Landscaping & planting	$183
Concrete	$12,987
Steel & Metals	$6,578
Roofing & Waterproofing	$2,180
General Construction	$5,384
Acid brick Flooring	$500
Pre-Engineered Structure	$87
Elevators & Escalators	$590
Fire Protection	$1,612
Plumbing	$2,504
Refrigeration	$2,215
HVAC & Sheetmetal	$15,138
Testing & Balancing	$108
ATC	$1,438
Electrical	$9,909

RS Means Square Foot Estimate

Using the online Costworks software from the RS means website, a square foot estimate was developed. However, a factory with the exact same characteristics as the Fuala plant expansion was not found; hence, the Estimate that was taken was for a factory was for 1 story only when the actual building had a mezzanine and a basement. However, the area used for the RS means estimate was not for the first floor but was actually the cumulative gross square foot area of the entire plant; this was accommodate for the basement and mezzanine that were not included in the story height calculation. In addition, the location adjustment factor was specified for a nearby city since the actual city was not listed. The values used in the software are as of 3rd Quarter of 2011. (See Appendix B)

Table 4: RS Means Estimate Summary

Stories	1 Floor
Perimeter	2407 ft
Story Height	33 ft
Floor Area	324,403 SF
Cost/SF	$98.31
Construction Cost	$31,892,500

RS Means MEP Assembly Cost Estimate:

The table below shows the approximate cost through an assembly estimate using the RS Means Assembly cost book. Although not every detail of the MEP systems went into the estimate; however, the main systems were included in the estimate as it can be seen in Appendix C. So this provides an overall estimate of the systems that were used and their approximate cost.

Table 5: RS Means MEP Assembly Estimate Summary

Mechanical	$10,825,328.11
Electrical & Telecommunication	$7,521,428
Plumbing	$352,809.3

Cost Comparison:

Table 6: Actual vs SQFT Estimated Summary of overall building cost		
Estimate Type	Actual	RS Mean SQFT Estimate
Cost/SF	$174.11	$98.31
Construction Cost	$56,481,000	$31,892,500

RS means does not account for sitework, fees, contingencies, insurances and so on. Hence, the Construction cost was compared instead of the Total Actual Cost. As it can be seen, there is a difference of $24,588,500 between the actual and the RS Means SQFT estimate. The reason for the big difference in cost is firstly because the RS Means SQFT calculation is an estimate; which means that there it is a calculation of very low accuracy. As for the reason for the big difference, the calculation made in the RS means relies on area, perimeter, story height and location; with that being said, the list of options of characteristics of the building being estimates is not even close to the actual building characteristics.

Table 7: Actual vs. Estimated Assembly Summary		
	Actual	Assembly Estimate
Mechanical	$15,138,000	$10,825,328.11
Electrical & Telecommunication	$9,909,000	$7,521,428
Plumbing	$2,504,000	$352,809.3

The table above shows the difference between the actual cost of the MEP system and the estimate cost through the RS Means Assembly estimate. It is a closer estimate to the actual value when compared to the RS Means SQFT estimate, and that is because there is more detail and accuracy when calculating the systems that are included. However, as it can be seen, the numbers still have a gap between them and that is due to the fact that the systems used could not all be found in the RS Means Assembly book and in many case, and so the system that is closed to the actual was chosen and assumed. These minor assumptions can cause drastic differences in the costs.

With all that difference, the Assembly was a good estimate that does what it is intended to do which is provide an close estimate to the building system that is wanted.

Site Plan of Existing Conditions

The aerial photograph shown above, provided by *Bing*, shows the site prior to the beginning of construction. The new west plant expansion will be constructed on the large area to the west of the original plant. The addition itself would be around two times the size of the old plant where it would be connected to the existing plant. The new addition will require the construction of new access roads with truck and employee parking areas. The existing site utilities will be extended to provide service to the new facility. The existing conditions and utilities could be seen in Appendix D.

The site has no structures in the in its vicinity except for the original plant. It is an isolated site with two main roadways that extend from the southwestern corner of the plant; a road with 2 lanes going both ways from the north and a smaller road with 1 lane going both ways from the south.

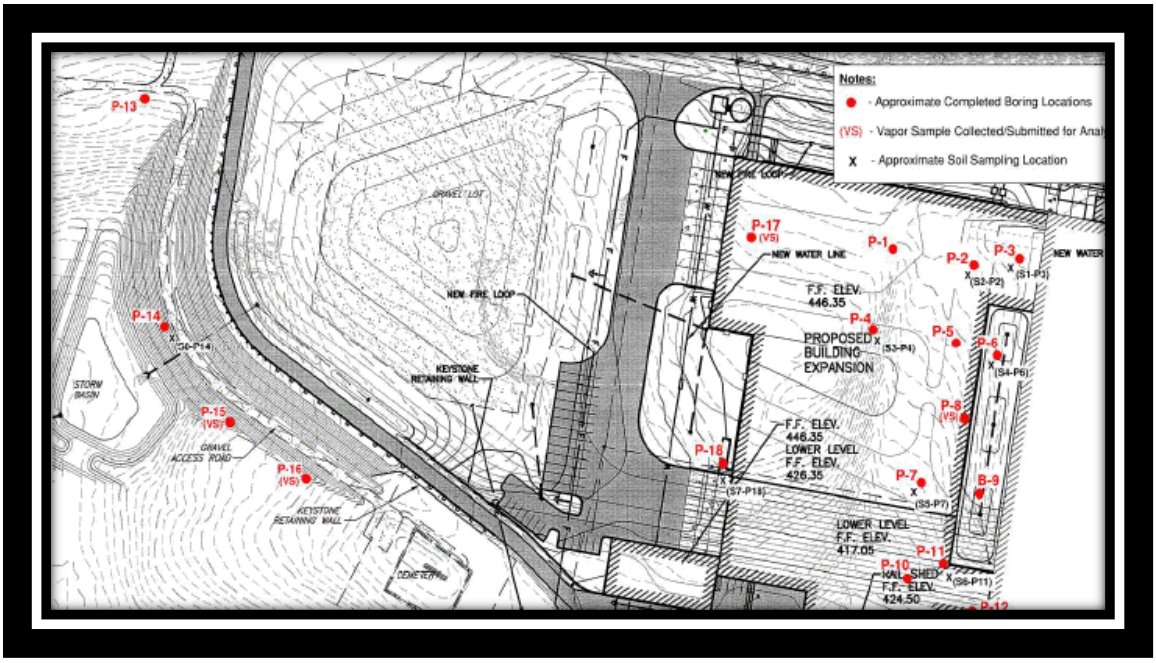
There is no foreign traffic coming anywhere near the factory. The only 2 types of people entering are : factory works that enter the factory from the southern road and park on the east side of the existing structure and will be able to get into the factory via a fenced path; Construction personnel and vehicles that enter the site from the Northern road.

Basically, Turner can manage the construction without having to deal with any interference from the surrounding since it is a fairly isolated site.

Local Conditions:

Even though the local area is commonly known for using structural steel for structural systems, the plant's west plant expansion is designed to have a concrete shell with the mezzanine being the only steel structure. Due to the isolated location of the plant, the project site has a large area available in which a large parking lot has been created for the contractors in addition to trailer spaces and a 'construction support area'. The only issue with parking was that parking had to be provided for plant workers where it was relocated twice to accommodate for the construction process and reworking the existing parking lot for the workers. As for recycling, up to 70% of non-hazardous construction and demolition debris will be recycled or salvaged.

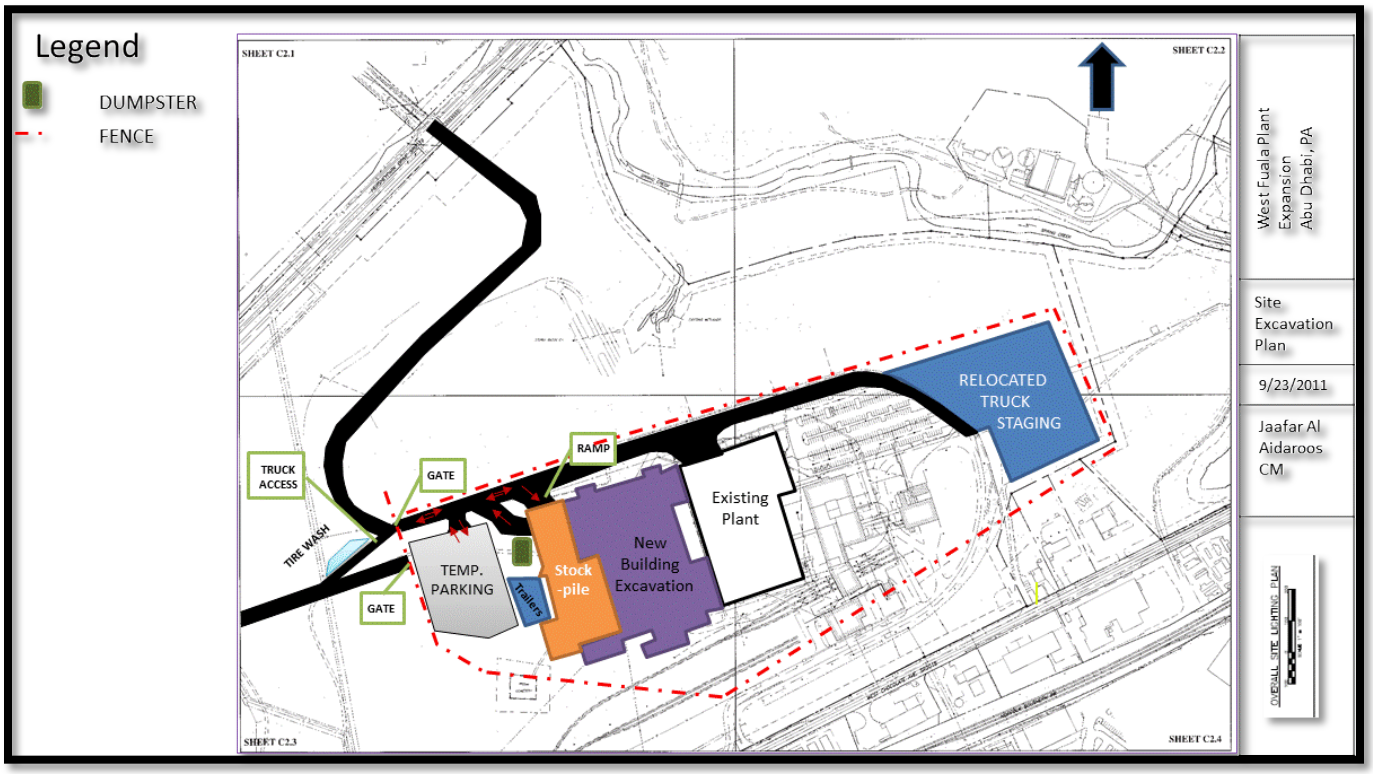
Due to the site's proximity to a former landfill operation; Turner investigated and generated "Site Phase 1 Environmental Assessment" which was done to identify the exact level of hazard, potential soil vapor impacts primarily methane. As a result a total of eighteen borings were completed onsite with fourteen completed within or directly adjacent to the proposed expansion footprint and four completed to the west of the proposed work area spanning the northern and southern extent of the proposed work. The locations of the borings can be seen in the picture below.



The lower explosive level (LEL) of methane is 5% and OSHA calls for an action level at 10% of this level or 0.5%. One of the samples had a methane result of 0.33%, or about 70% of the action level. This methane concentration suggests there is a potential to encounter methane concentrations at or above the action level during construction and thus this should be incorporated into Turner's Site-Specific Health and Safety Plan for the project.

Site Layout plans:

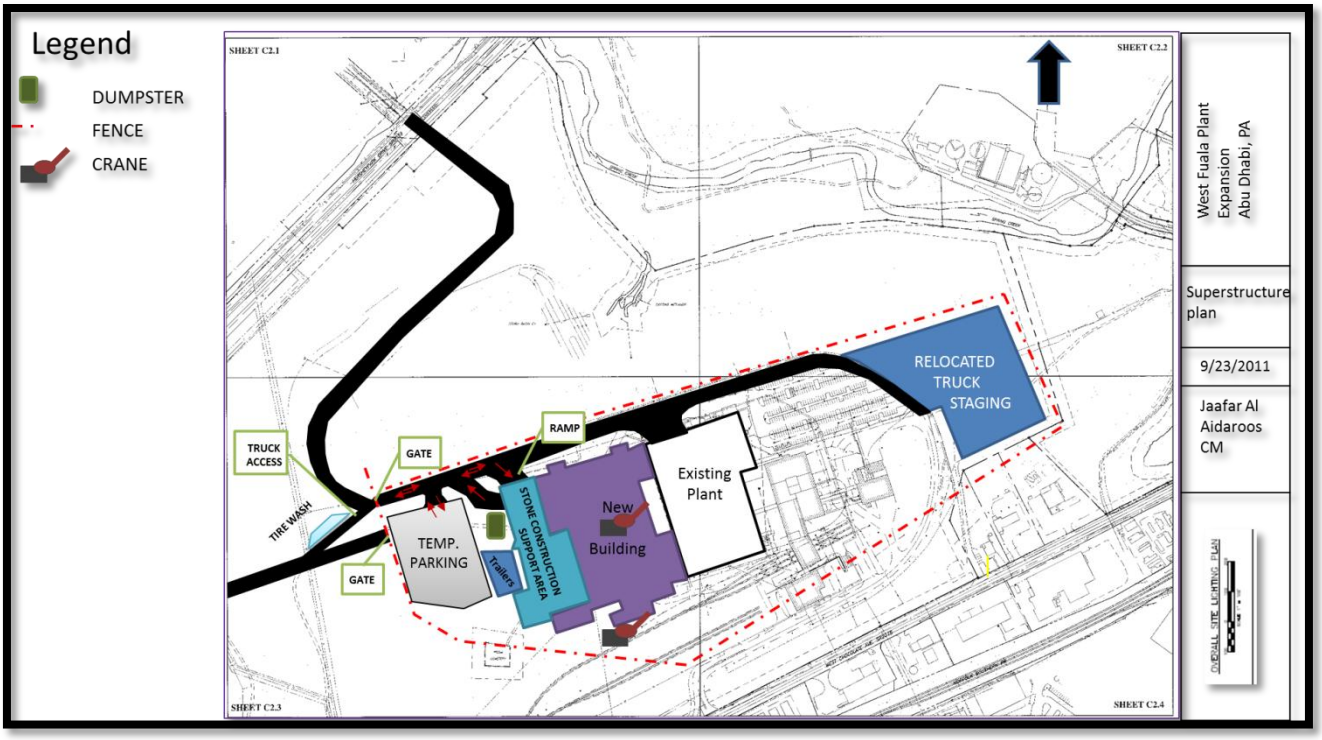
Excavation Plan



At first, Sitework had to be done before the excavation phase could start. Access roads were created from the North side that would connect to the road; this would be used as the supply access road for trucks, construction vehicles and delivery of materials. A temporary parking lot was established to the west of the west plant in addition to an open area (Marked in orange). In addition, Truck staging was relocated to the east of the old plant. After which, the excavation process can begin.

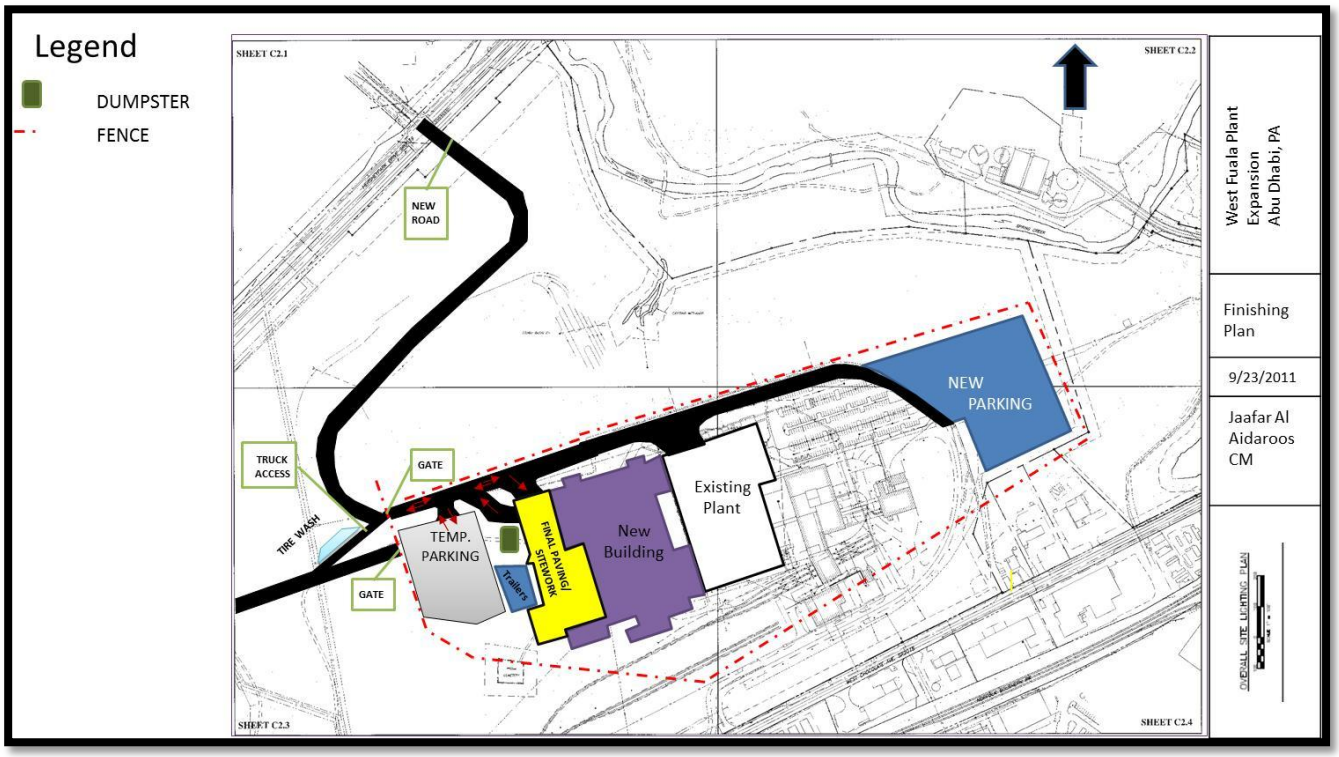
As for the layout critique, the north road is very essential for delivery purposes especially that the southern entrance is still being used by the workers in the original plant on a daily basis. In addition, the north access will be used in the future even after the construction project is complete where traffic will be much smother especially that a larger plant means more workers.

Superstructure Plan



In the superstructure phase most of the sitework is completed and all the work that is required will be around and within the structure. The stockpile area can still be used as a stockpile area where it is labeled in the plan above as 'Stone Construction Support Area'; however, since the building floor has been constructed the materials can now be placed in and around the structure. The crane for the erection of the precast panels will start from the south to the north; hence, one of the cranes was located below the building where it will start placing the precast concrete in place while the other crane works on the north side. Afterwards, the crane in the center of the structure would erect the central area while backing up to finish the superstructure erection process.

Finishing plan:



The final phase would be the finishing stage where all the work would be within the structure. The area that was used as a support for construction (in yellow) would eventually become a parking lot; hence, the paving and sitework phase begins in that area. In addition, the parking lot to the east of the plant would be reconstructed and completed to provide a new parking area for the workers while the construction process is still taking place and for after the completion of the project. All sitework would be finalized and completed.

See Appendix E for 11” x 17”

Client Information

The Fuala Co.'s is one of the largest chocolate factories and distributers worldwide. It all started in 1894 when the first decision to start producing was made; production continued and expanded in 1900. Now Fuala is exports to over 90 countries with approximately 13,700 employees and net sales in excess of $4billion. The Fuala Company remains committed to the vision and values of the man who started it all so many years ago.

The new West Plant expansion gained approval from the township which would turn this century-old plant to a modern state of the art facility. The existing 105 year old plant will become office spaces while the new plant expansion will expand production to be one of the world's largest and more advanced chocolate-making facilities. This expansion would lead to major growth in the facility and in turn will lead to growth in the stock market as it is one of the biggest gainers in the S&P 500 Index.

Project cost and budget is an important factor in order to meet the owner's expectations. This project is self-funded by the Fuala Company as an investment to its ever-growing and productive facility. The project changed from what was intended to be a $53.7 million expansion to an $83 million project. With that being said, Fuala has been very satisfied with the work done by Turner as the General contractor even though there have been a lot of changes in the scope of work.

Safety is also a very important factor in the construction process of this project as it is in any construction project if not the most important factor; hence, a lot of efforts have been made to maintain this standard. In addition to that, quality is very critical since this west expansion is for the next 50 to 100 years in which everything has be as good as new in order for it to do its intended purpose; especially that this will be the new main plant where all the products will be processed and shipped nationwide and worldwide on a 24 hours a day, 7 days a week schedule. Which mean that there a very low opportunity for mistakes or faults as this will take place to be the one of the world's largest chocolate plants in the world.

The most sensitive factor that is specific to this project is isolation between systems that may cause allergic reactions; especially that plant is a major almond processor. And so, a lot of care and attention was given to the factor that there had to be solid isolation between the nuts processing section and the other sections. Rooms have been separated with sealed walls with no doors; the worker's bathrooms have been segregated between the two sections where workers

would not even have the ability to go into the other section if they have been in the first. In addition, each section would have their own entrance, so much that the workers working in the facility may not meet or know the workers working in the other section in order to keep both sections running as clean and as isolated as possible. There are a lot of things that have been taken into consideration to maintain a clean and segregated environment such as have separate HVAC systems so that even particles may not be able to travel through the systems to the other side.

As for sequencing, there were several sequencing issues that contributed to the current approach on the project beyond meeting the Contractual Milestones. Firstly, the office building expansion includes upgrades / reconfiguration to the existing Locker rooms which are in constant use. This has required Turner to perform certain work during plant shutdowns and will require partial completion of the new locker spaces to allow workers to be shifted out while they retrofit the existing. In addition, maintaining operating plant access, employee entrances, roadways, and so on had to be taken into account in planning all of the site improvements to minimize the impacts to daily operation since the facility operates 24/7 except for planned shutdowns over Thanksgiving and Easter.

Building erection sequence

There were no specific sequencing requests initially; however, to recoup some schedule time lost during preconstruction (due to the changes in scope), the precast erection was bought utilizing 2 cranes to cut their installation schedule from 22 weeks to 12 weeks. While the basement area (A-E) was erected from outside the footprint, the area (E-Q) was erected from inside the footprint. Their erection sequence (and requirements for crane roads / delivery access, etc.) drove the installation of the Underslab plumbing and foundation concrete work for this area (E-Q).

As far as occupancy is concerned there were no specific goals for a phased occupancy in the traditional sense, but Fuala's process installation requirement has definitely caused Turner to "jointly occupy" and work in the building. This has been one of the key challenges for them in the later stages of the project. Turner has scheduled / tried to get as much of their work complete prior to Fuala mobilizing in areas but once they started, as they has been competing for work and laydown space with increased pressure to get done.

Key measurements for success are like most projects, complete the project on schedule (hit the critical milestones), within budget, and have the quality necessary for a food manufacturing facility. To ensure the quality will be acceptable, Turner is meeting for weekly walkthroughs with Fuala's Quality Assurance group to perform interim inspections and review construction progress prior to overall completion. Turner has also been very flexible and accommodating to the multiple changes and impacts from the process installations that have occurred over the course of the project so far.

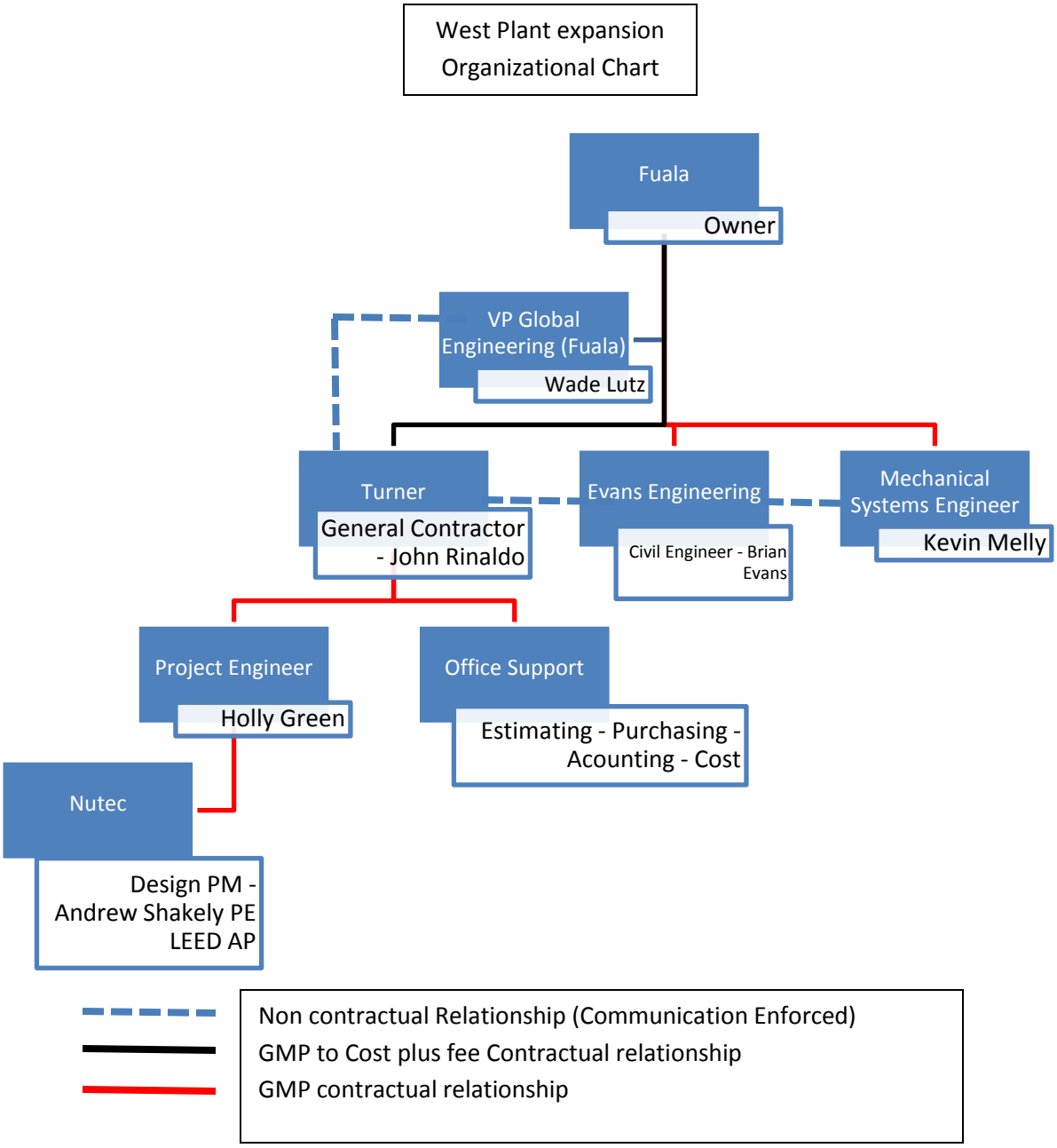
Project Delivery System

The Fuala Company chose a Design-Build approach from the beginning. Initially, Nutec Group took the lead as the Architect and Engineer of the project which is where the initial design was created. Evans Engineering is a relatively small local firm from the area that took the role of the civil engineer in addition to working with zoning regulation and the geotechnical issues. Nutec and Evans were there first of the project team were they worked on the design and initial paper work and permits. Later on Turner was chosen as the General Contractor that would take the project from paper and plans to construction and completion. They joined the team earlier and assisted in the pre-construction phase with architects and engineers in order to facilitate and be able to manage the project effectively and efficiently.

Even though the project team collaborates and works together in this project to complete the construction process as smoothly and as effectively as possible; they are all separate from each other with each having its own contract with the owner. The rest of the contractors are working through Turner and communicates and worked in the project under the wing of the General contractor as separate subcontractors.

As for the selection of Turner, selected Construction Management/General Contractors were invited to submit proposals then Fuala negotiated with a specific selected group and was awarded to Turner. With regard to the subcontracts with Turner, Turner created scopes of work which were provided to Turner and Hershey approved the contractors to bid. Upon the receipt of proposals, the low 3 to 4 contractors for each trade were brought in to review their scopes of work to assure all required work had been included. Subcontractors then submitted best and final offers based on the scope review meetings where the low bidder was awarded the project. The owner allowed Turner to provide Subguard on the project in lieu of bonds. Onsite insurance coverage for Turner and their contractors is provided by Turner's Contractor Controlled Insurance Program. The owner is providing the Builder's Risk Insurance Coverage with Turner providing an add on policy to coverage water infiltration loss.

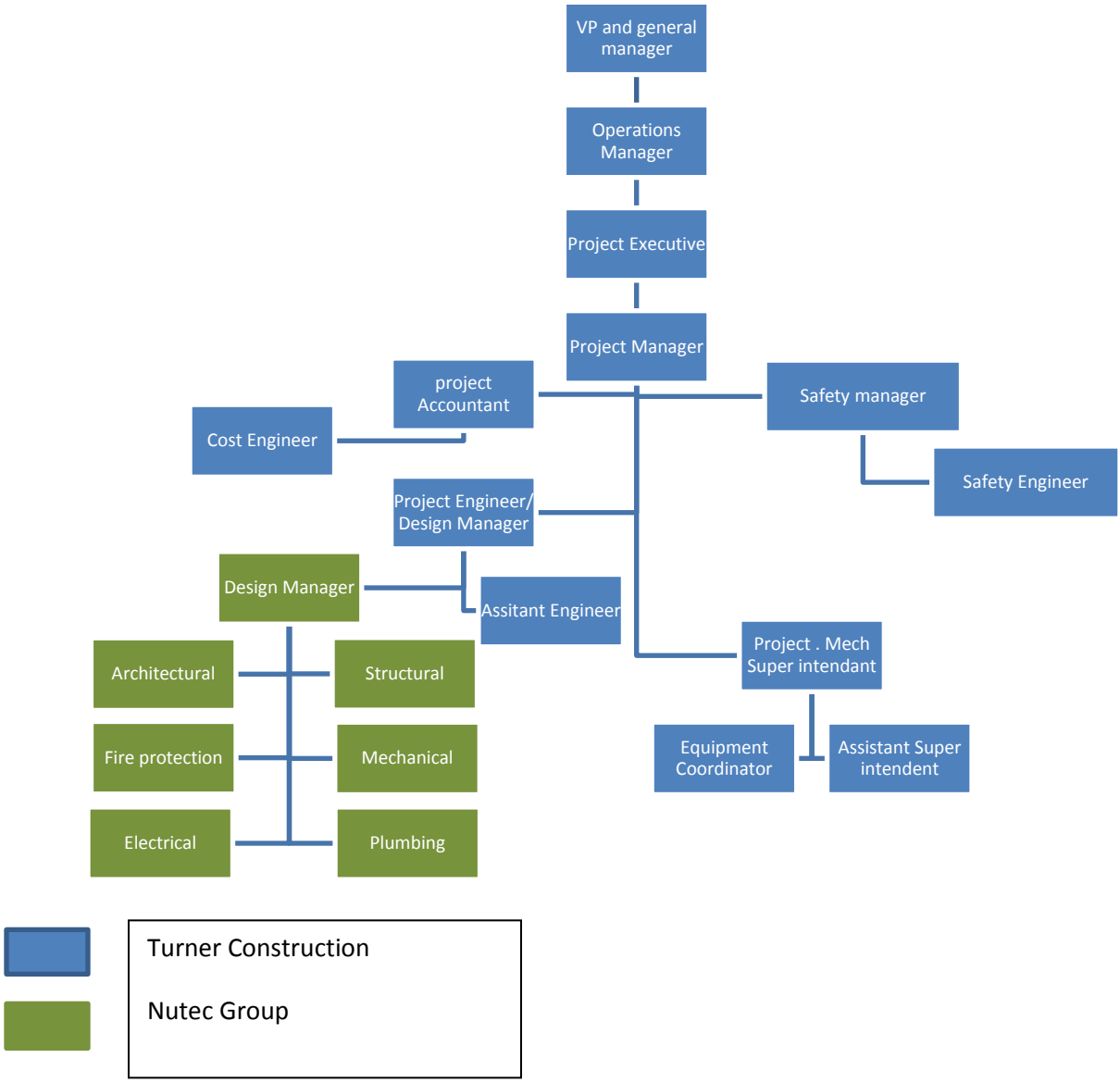
The project was initially a Guaranteed Maximum Price (GPM) that later became a Cost plus fee as a result of the drastic change in scope that occurred as requested from the owner. The general contractor agreed to make any changes on the project to cater to the desire of the owner through the cost plus fee contract that was established.


West Plant expansion
Organizational Chart
Fuala
Owner
VP Global Engineering (Fuala)
Wade Lutz
Turner
General Contractor - John Rinaldo
Evans Engineering
Civil Engineer - Brian Evans
Mechanical Systems Engineer
Kevin Melly
Project Engineer
Holly Green
Office Support
Estimating - Purchasing - Acounting - Cost
Nutec
Design PM - Andrew Shakely PE LEED AP
Non contractual Relationship (Communication Enforced)
GMP to Cost plus fee Contractual relationship
GMP contractual relationship

CONFIDENTIAL:

As for the reason for the drastic change in scope, the project initial design was performed by 5 people in the Fuala's Global Engineering Department. This allowed Fuala to get pricing for the building in a highly confidential manner. The owner actually got pricing for the building at the site we are working on as well as an alternate site. The reason for the confidentiality was Fuala needed to get approval for the union to close the old plant building and open the new facility Turner is constructing. The vote could not take place until June 2010 but the initial design in late 2009 with bidding/award in 1st quarter 2010. Due to the confidentiality of the project, the 5 person team that created the original program for the building was not able to get input from process engineers and plant management. As such, the initial design did not accommodate the requirements of the processes to be housed in the building. There were several large increases in the project budget from $ 55,134,000 to the current $85,339,869. The most recent changes that took the budget to the current $85,339,869 didn't occur until May 2011. By contract, Turner was to submit Amendment #1 by 1/15/11. At that time the requirements of the project were in major flux so Fuala asked that the Amendment be placed on-hold until further notice. The project design didn't get finalized until May 2011 and at the time Fuala asked that Turner continue as they have been during the project with submission of change order requests for changes in the project scope and then formal AIA change orders for selected changes. In May, the Fuala and Turner team agreed to the budget of $85,648,119 and Fuala stated that rather than spend approximately $50,000 to develop a formal GMP the project would continue with COR and AIA change orders.

Staffing Plan:



The staffing Plan is structured in a way so that everything goes through Turner Construction Company even though some have direct contracts with the Owner. The Staffing Plan above shows the relationship between the two major companies that are working on this project. Nutec group is the design team that includes all designers for the project. The Design team has to communicate with the Project engineer of Turner and reports to the same person. On the other hand, the Turner team is branched in a way that all communication goes through

The Project manager and operation Manager both report to the VP of Global Engineering (part of Fuala) which is main line of communication between the owner and the project team. All other contractors report to the owner directly however, Turner receives all updates as well as a result of this communication line. A meeting is held every Wednesday between the owner, Turner, Nutec group and Evans engineering. In addition, Turner meets as well with the inspection staff in order to ensure that the plant maintains a clean environment according to the drug and food administration requirements. These sets of meetings facilitate all problem solving issues and ensures that things get resolved in a timely manner and induces communication between all parties.