Final Senior Thesis Report
Spring 2007

T.C. Williams High School
Replacement Project

*all images are provided by Hensel Phelps Construction Company & the Alexandria City Public Schools

Construction Management

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T.C. Williams High School

Alexandria, Virginia

PROJECT TEAM:
Owner: Alexandria City Public Schools
General Contractor: Hensel Phelps Construction Co.
Architect / MEP Engineers: Moseley Architects
Civil Engineers: Adtek Engineers
Food Service Consultants: L.J. Huber & Associates, Inc.
Acoustical Consultants: Orpheus Acoustics
Landscaping Consultants: Edaw, Inc.

ARCHITECTURAL FEATURES:
- Thermoplastic Polyolefin (TPO) & Ethylene Propylene Diene Monomer (EPDM) membrane roofing systems with prefinished metal at entries & on roof garden clerestories.
- Prefinished aluminum curtain wall.
- Aluminum composite panel facia.
- Precast concrete coping.
- Face brick veneer.

CONSTRUCTION OVERVIEW:
Site: 3330 King Street
Alexandria, Virginia 22302
Function: Educational Facility
Size: 469,507 sq. ft. (school only)
Cost: $90 Million
Construction Timeline: December 2004-August 2008
Stories Above Grade: 3 floor levels
Classroom towers 45'-8" high
Project Delivery Method: Originally Design-Bid-Build, changed to Design-Build at 100% design completion.

MECHANICAL SYSTEMS:
- Variable Air Volume (VAV) System with (305) terminal units equipped with reheat coils.
- (17) rooftop & (4) indoor air handling units (AHU) ranging from 1,400 to 23,295 cfm with enthalpy wheels to recover total energy.
- Four pipe system supplies / returns hot & chilled water to (12) fan coil units.
- Variable speed control pumps drive the variable flow hot & chilled water plant of (4) 1.68 million BTUH natural gas-fired condensing boilers and (2) 600 ton water cooled electric driven centrifugal chillers.
- (2) 750 ton cooling towers condense the R-123 refrigerant that re-circulates through the chillers.

STRUCTURAL SYSTEMS:
- Foundation is comprised of continuous and spread footings.
- First floor level is slab on grade
- Classroom towers are a structural steel moment frame.
- 4-1/2" thick elevated concrete slabs on composite metal decking
- Technology wing, gymnasium and auditorim are single level, multi-height spaces with load bearing CMU walls.
- Roof structure is metal roof decking on k-series open web joists.

FIRE PROTECTION SYSTEMS:
- Five zone wet sprinkler system.
- Each zone covers 49,855 to 51,000 sq. ft.
- 100 HP vertical in-line fire pump produces a flow rate of 1,000 GPM with a total head pressure of 120 psi.
- Mixture of sidewall, pendant and concealed sprinkler heads.

ELECTRICAL SYSTEMS:
- 480 Y / 277, 3 phase, 4 wire primary feed.
- (2) main 4000 amp. 3 phase switchboards
- Direct feed from utility service to chiller switchboards.
- (2) 800 kW, 480 V, 3 phase, 60 Hz, diesel fueled generators for life safety.

CISTERN:
- Reduces the buildings non-potable water load by circulating collected rainwater.
- Constructed of a 20" thick reinforced mat slab, 15" thick cast-in-place concrete walls, and a 15" thick cap slab supported by (24) 20"x 20" concrete columns.

Kyle Conrad - Construction Management

CPEP Website: http://www.arche.psu.edu/thesis/eportfolio/2007/portfolios/KAC357/

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APPENDIX

A. Executive Summary :

The final report for the T.C. Williams High School Replacement Project revisits the technical analyses pertinent to the development of a value engineering exercise that proposes an alternate to the original design and initial construction sequencing of the project. The analyses are tied together by the implementation of a Building Information Model that focuses on the interoperability between different software platforms required to perform all aspects of the exercise.

Extensive building material research has uncovered a partially prefabricated structural insulated concrete panel that will significantly improve the energy efficiency and erection time of the superstructure for the auditorium, gymnasium, mechanical/electrical wedge, and automotive strip of the T.C. Williams High School which was initially designed with CMU load bearing walls. A detailed description and construction sequence of the Solarcrete system exposes the potential for off-site controlled environment fabrication and just-in-time delivery to reduce field labor and material storage. The Solarcrete wall system will provide enough flexibility in the erection sequence of the aforementioned areas to allow the general contractor, Hensel Phelps Construction Company, to capitalize on a re-sequenced superstructure plan to alleviate site congestion and improve project safety.

A cost comparison exposes the Solarcrete system's higher initial cost while pointing out areas of potential cost savings due to the system's superior energy efficiency over the traditional CMU design. The analysis leads to redesign of the gymnasium acoustics to maintain the reverberation levels of the original design. An economical solution is presented through to procurement of FABRISORB™ high impact resistant acoustical wall panels. While the acoustics of the auditorium would generally be of greater concern due to the type of events held in the space, they were not considered since the initial design sought to improve the aesthetics of the space by completely covering the structural CMU walls with higher end finish materials. Therefore, the redesign of the structural system would have a minimal effect on the room acoustics in the auditorium.

Interoperability between the architectural and structural models is explored further through the design of a structural moment frame for the gymnasium. Research uncovered the standard practice of erecting a moment frame for the Solarcrete system when tall panels are employed that will be exposed to lateral loading.

The project aims to reveal the effectiveness of Building Information Modeling in value engineering, work sequencing, and site logistics while expressing the importance of BIM in our industry and the potential for implementing non traditional building materials to increase project value.

B. Project Background :

a. Overview :

The condition of the existing T.C. Williams High School building has been degrading over the last 50 years. The structure was originally designed to house grades 9th through 10th, but over the last five decades, the population of the district has grown and the freshman class had to be relocated to another facility. In addition the school district had been forced to hold classes in temporary classroom trailers.

The new 469,507 ft^2 educational facility is designed to provide the school district with all of the amenities required to facilitate the education of its students. T.C. William's high school contains ample administration and standard classroom spaces as well as specialty classrooms (biology, marketing, chemistry, etc.), a planetarium, computer and science labs. A large commons area provides students with a pleasant dinning experience without having to leave the campus or exposing them to the traditional cafeteria style facility. The large auditorium has operable partitions that can be closed to create multiple lecture halls and for those students who have children of their own, they can now bring their babies to school with them. The "babies with babies" program provides daycare services to toddlers and infants which in turn creates a living lab to teach teenage parents, or expecting parents, appropriate parenting skills. An auxiliary gymnasium was added to provide additional multipurpose space for the main gymnasium. Protruding from the sides of the main 45'-8", three story, classroom towers are the music suites and auto service technology shops.

The owner, Alexandria City Public Schools, is the governing body of the Alexandria, Virginia school district. They are devoted to constructing a building that is both sustainable and reduces the consumption of raw materials, energy and impacts on the environment. An assigned owner representative, Dan Pierce, works with the general contractor, Hensel Phelps Construction Company [HP], to ensure that the client's expectations are exceeded.

b. Building Systems :

i. Demolition :

Phase A-1 was the demolition of the existing one story, career tech wing that was built on to the original school structure in the 1970's. The 22 ft. high structure required abatement for asbestos. Since the lead paint was contained, no abatement was required to remove the lead. After the new school facility is completed, phase B-1 will commence. In this phase, the existing three story, 45 ft., T.C. Williams High School building will be demolished to make room for the construction of the parking garage. Asbestos abatement will be required during the demolition in phase B-1 as well.

ii. Structural System (includes aspects of Structural Steel Frame, Cast-in-Place Concrete & Masonry) :

The foundation is designed for an allowable bearing capacity of 6000 psf. The soil has been classified as a type C soil. Due to poor soil conditions, areas of the foundation are supported with geopier rammed aggregate soil reinforcements. A machine, similar to a caisson drilling rig, bores holes into the soil and then packs crushed stone, in thin lifts, into the cavity to provide a solid base for the footing that rests on top of the geopier. A continuous footing system, 16 inches in depth, supports the extensive lengths of exterior and interior CMU walls. Spread footings distribute the loads from the steel columns. A series of grade beams and braces tie between the spread footings.

The classroom towers are three story, steel moment frame structures. The beams and girders are a wide range of ASTM A992 wide flange sizes and the columns range anywhere from ASTM A992 wide flange shapes (W) to ASTM A500 rectangle and round hollow structural shapes (HSS). The 4000 psi, cast-in-place, elevated concrete slabs are typically 4-1/2 inches thick over 1-1/2 inch – 18 gage composite galvanized floor deck that spans the beams. The concrete will be pumped to the areas where concrete is being poured. The k series open web steel joists bear on the beams which transfer the roof loads from the various specified metal roof decking to the columns. A 50 ton, mobile all-terrain crane was utilized by the steel erector. The mobile crane was primarily set in locations between the two classroom towers.

The East wing of T.C. Williams and the rooms at the South end of the classroom towers are single level, multi height spaces. Load bearing CMU walls, of varying thicknesses, run around the perimeter of the auditorium, gymnasiums, exterior of the East (technology) wing, and South wall of the school. Beam pockets in the CMU provide a bearing surface for the W-shape beams while the majority of the k series roof joists are tied into bond beams at the top of the CMU load bearing walls. The loads in these areas of the structure are transferred to the continuous footing.

Classification of Building Category / Use Group: II

Codes: 2000 VUSBC
2000 IBC (Effective 10/01/2003)
ACI 318-95 Building Code Requirements for Structural Concrete
ACI 301-96 Standard Specifications for Structural Concrete
AISC Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design – June 1, 1989
AISC Code of Standard Practice for Steel Buildings and Bridges – March 7, 2000

iii. Pre-cast Concrete :

An architectural pre-cast concrete ribbon runs around the majority of the building's perimeter and below various window units. The east and west sides of the facility contain architectural pre-cast concrete coping.

iv. Mechanical System :

Seventeen rooftop air handling units, ranging from 1,400 to 23,295 cfm, supply conditioned air to the majority of the spaces and employ the use of enthalpy wheels to recover total energy. Supply air entering the gymnasium, auto services, and building trades / construction technology spaces passes through reheat coils. Four additional indoor air handling units control the air in the auxiliary gymnasium, east and west commons areas and the remaining spaces in the East (technology) wing. The variable air volume (VAV) system utilizes 305 terminal units; most of them are equipped with reheating coils which are only activated when the minimum amount of supply air is being forced into a space. A four pipe system supplies and returns hot and chilled water to and from twelve fan coil units that locally returns and supplies conditioned air.

In addition, a water unit heater and an electric unit heater service the mechanical and equipment rooms respectively. A direct gas heating, make-up unit in the kitchen activates when the demand arises due to the large quantities of room air that are exhausted through the hoods.

The variable flow, hot and chilled water plant is driven by variable speed control pumps. Four natural gas-fired condensing boilers, with capacities of 1.68 million BTUH, heat water from 120°F to 160°F. Water is cooled to 38°F by two, 600 ton water cooled, electric driven centrifugal chillers. Two 750 ton cooling towers condense the R-123 refrigerant so that it can be re-circulated through the chillers which will accept the heat from the systems chilled water lines.

The mechanical contractor brought in a 100 ton mobile, all-terrain crane for a duration of two days to set the mechanical equipment.

A five zone, wet pipe sprinkler system services T.C. Williams High School. Each zone covers 49,855 to 51,000 sq. ft. A 100 hp vertical in-line fire pump produces a flow rate of 1,000 GPM with a total head pressure of 120 psi. A mixture of sidewall and pendant sprinkler heads will service the spaces while concealed heads are required in all the stairwells.

Required Codes: NFPA 13
VUSBC
Local Authority: Virginia – American Water Company

v. Electrical System :

A 480 Y / 277, 3 phase, 4 wire primary feed services the building. Two main 4000 ampere, 3 phase switchboards distribute the required power to the electrical loads throughout the building. Separate switchboards for the chiller units are feed directly from the utility service. The life safety system is backed up by two 800kW, 480V, 3 phase 60 Hz, diesel fueled generators.

vi. Masonry :

The majority of the exterior wall system is face brick with CMU backing. The interior partition walls are primarily constructed of CMU as well. The masons utilize two scaffold systems which include a standard Mason King tube and coupling scaffold and a jacking platform system that mechanically raises and lowers to facilitate the laying of block and brick.

vii. Curtain Wall :

The court is enclosed in a pre-finished aluminum curtain wall system. Aluminum curtain wall units also span from the majority of second floor to first floor window openings of the classroom towers. The units are hoisted into place via a crane and secured on the floor levels to transfer the applied loads through the structural steel frame.

viii. Roofing System :

T.C. William's roof is primarily a Thermoplastic Polyolefin (TPO) Membrane system on a steel roof deck. The clerestories, which were constructed to allow natural light to enter the building through the roof, utilize pre-finished standing seam metal roofing systems except for one clerestory that has an EPDM membrane system. A pre-finished, sloping, standing seam, metal roofing system accents the two main entryways into the school facility while the garden roof assembly obtains additional LEED points.

ix. Support of Excavation :

Since the building was designed as a slab on grade structure and the site was relatively level, no significant excavation was performed that required additional support systems to be implemented. Permanent retaining walls were constructed at the south east corner of the site. Shot-Crete was sprayed onto the reinforcing rebar cage to minimize the amount of formwork required on site.

c. Project Delivery System :

The project was originally set up as a design-bid-build delivery method and was procured through a competitive hard bid. Hensel Phelps was the lowest bidder and was awarded the job. At 100% design completion, HP convinced the owner to transfer the risks associated with errors and omissions to HP by restructuring the project into design-build **(see figure 1 below).** Hensel Phelps holds the sole contract with the owner. After four months of GMP contract negotiations, a GMP was approved and HP was given the notice to proceed on the construction of phase A-2. The original architect, Moseley Architects, signed a new lump sum contract with Hensel Phelps under the new system. The design-build structure provides HP with an opportunity to actively pursue value engineering ideas. All potential value engineering [PVE] ideas are submitted to the owner and the architect for review. If the PVE is approved by both parties, the idea is executed. For their review time, HP agreed to pay the architect 8% of the cost savings from the executed PVE. The remaining cost savings are either kept by HP or passed down to the appropriate subcontractor.

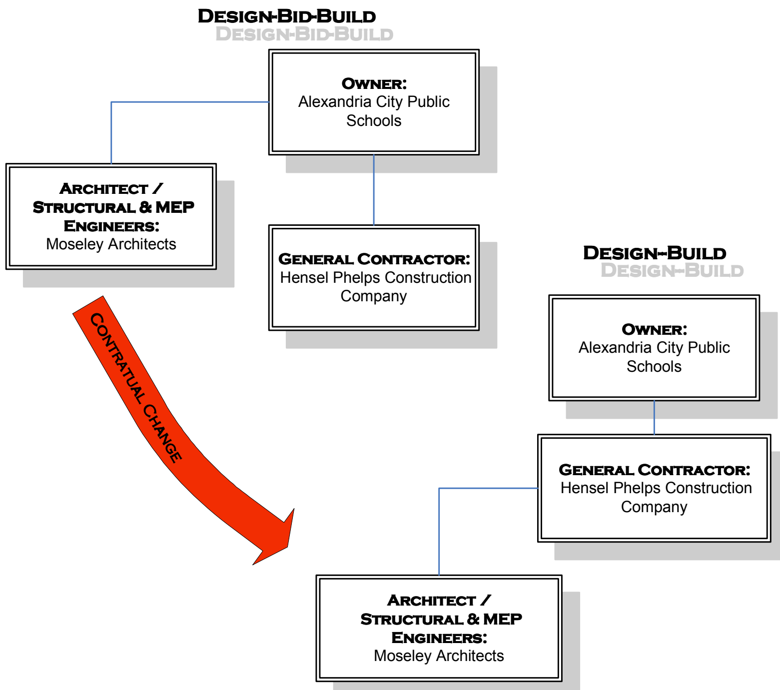


Figure 1 Restructuring of the project delivery system

While HP required each subcontractor to submit payment and performance bonds, the owner only required that HP provide a performance bond for the full amount of the project. All of the subcontractors hold lump sum contracts with Hensel Phelps except for the concrete contractor responsible for placing and finishing concrete. The concrete contract is unit price, based on the square foot of concrete. The rate varies depending on the thickness of the concrete. A thicker pour results in a lower rate. Refer to the project organizational chart **(see figure 2 below)** for a clear understanding of contractual arrangements.

d. Organizational Chart :

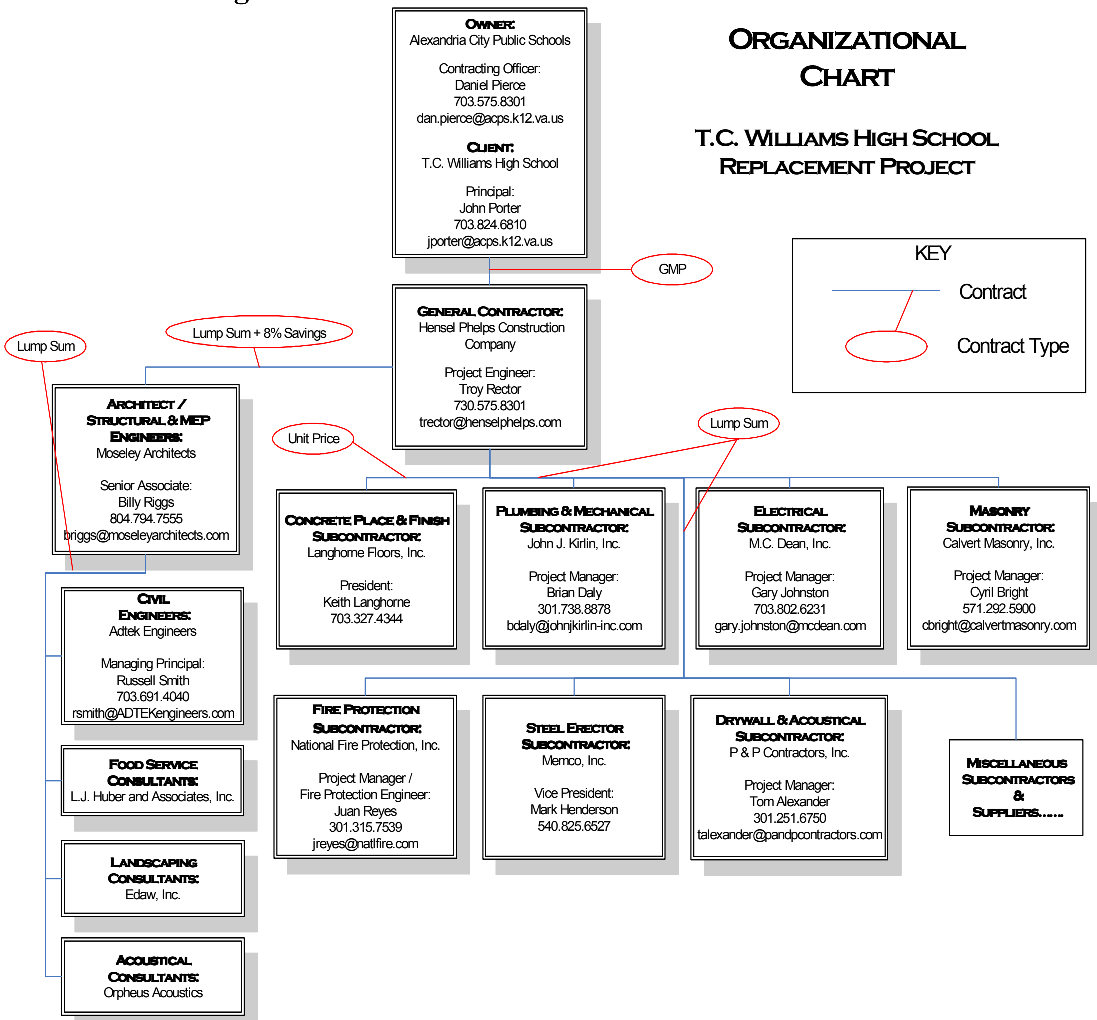


Figure 2 T.C. Williams High School Replacement Project Organizational Chart

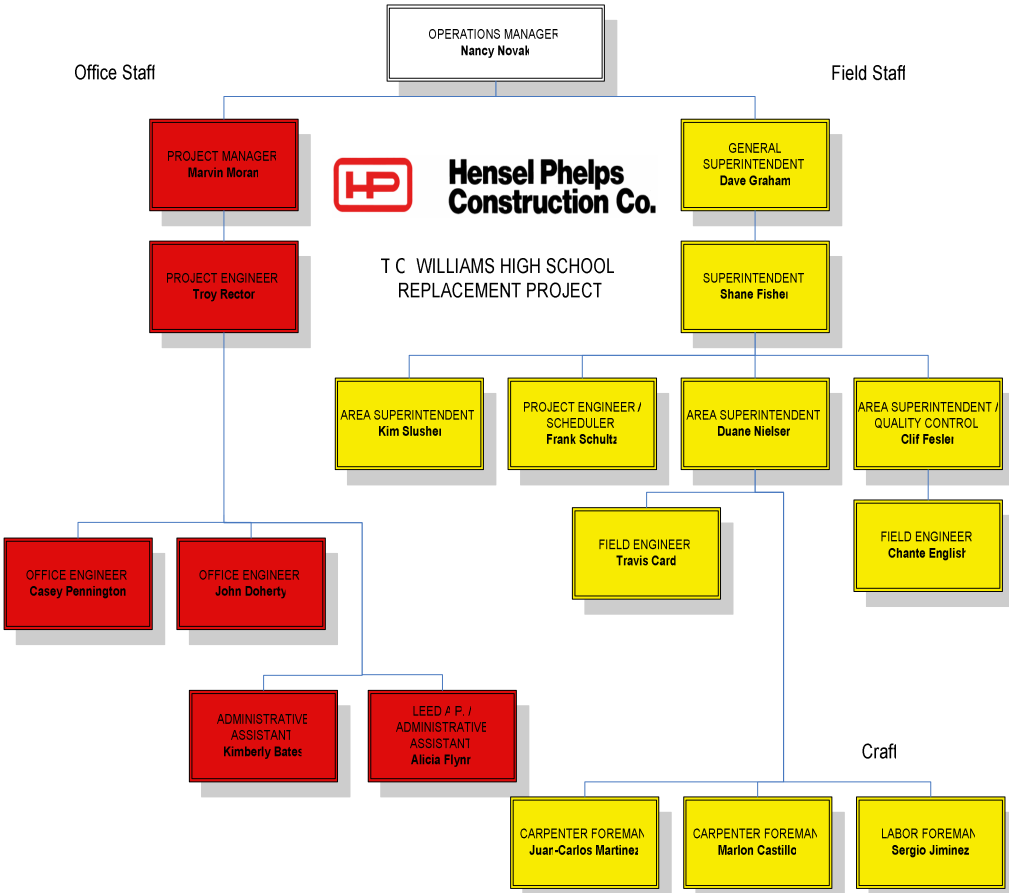


Figure 3 Hensel Phelps Construction Co. Project Staff Organizational Chart

e. Staffing Plan :

Hensel Phelps Construction Company **(see Figure 3 above)** provides a full time project management and field supervision staff on-site, complete with 17 carpenters and laborers to self-perform work.

General Contractor Self-performed Work:

- Door Frames, Doors, & Hardware
- Fire Extinguisher Cabinets
- Projection Screens
- Cast-in-place Concrete
  excluding site concrete (foundations, SOG, SOD, stairs)
- Site Erosion Control Maintenance
- Safety Maintenance (fall protection – handrails & hole covers)

The office staff is overseen by a project manager and project engineer. Since the T.C. Williams High School Replacement Project is seeking a LEED rating, Hensel Phelps sent an interested employee to train for her LEED certification. The general superintendent and superintendent are in charge of assuring that the work being performed in the field is in accordance with the design and on time. Hensel Phelps has a dedicated quality control department on-site to guarantee that the work in place meets their company's high standards as well as the expectations of their client.

C. Current Management :

a. Project Schedule Summary :

To permit the continued education of the student body on campus through the duration of the construction, the T.C. Williams High School Replacement Project was separated into four phases. The two A phases encompass the construction processes for the new school facility, while the B phases cover the construction of the two deck parking garage. Refer to **Appendix A** for a project summary schedule of phases A-1 and A-2.

i. Phase A-1 :

As depicted below, Phase A-1 **(see figure 4)** involved the demolition of the existing career tech wing, the removal of five temporary classroom buildings and the installation of two temporary classroom units in the center of the renowned Titan football field. Student parking was relocated to the eastern side of the lot and construction fence was installed around the perimeter of the A phase construction site boundary. Modifications to the bus loop and the storm sewer at King Street were required as well as the construction of a retaining wall along the East property line.

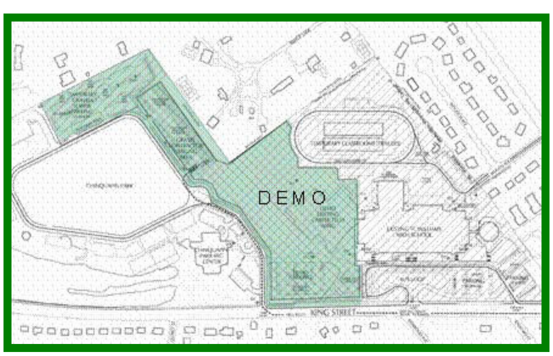


Figure 4 Phase A-1

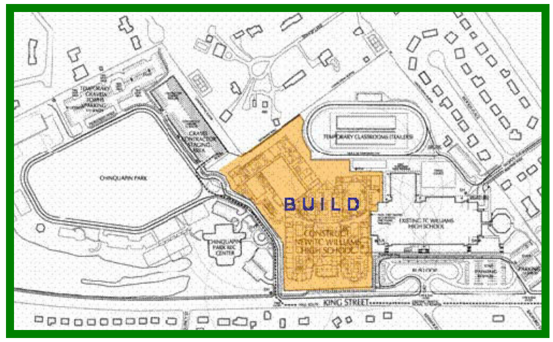


Figure 5 Phase A-2

ii. Phase A-2 :

Phase A-2 **(see figure 5)** concludes on 20 July 2007, as the construction of the new T.C. Williams High School reaches final completion.

iii. Phase B-1 :

Over the summer months of 2007, the district transitions from the existing school building to their new facility as the contractors repair the football field, after the removal of the temporary classroom units, and prepare for the demolition of the old school building. The contractor staging area is relocated to the North end of the construction site and another temporary parking area established in its place. After the temporary construction site fence is relocated, the demolition of the old school commences in Phase B-1 **(see Figure 6 below).**

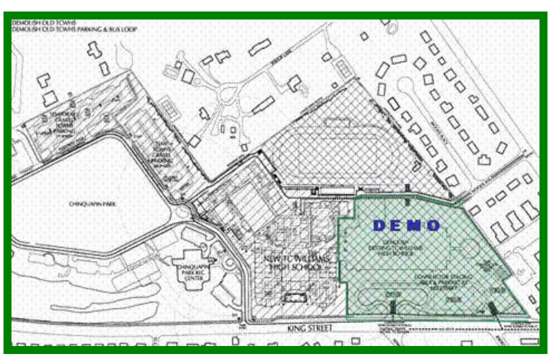


Figure 6 Phase B-1

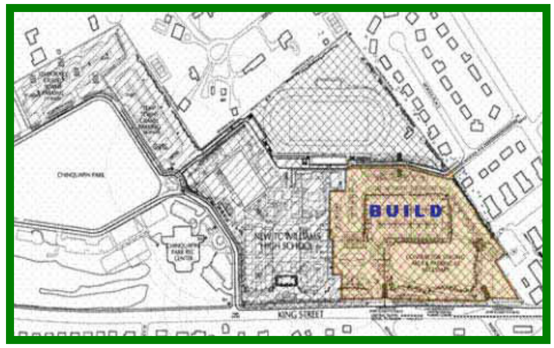


Figure 7 Phase B-2

iv. Phase B-2 :

The project concludes with Phase B-2 **(see Figure 7 above)**: The construction of the pre-cast concrete parking garage. As the project comes to a close, the bus and entry loops are completed and the practice fields are graded and restored. B phases will not be considered in the development of this thesis project, due to the size and complexity of the high school facility.

b. Detailed Project Schedule :

Hensel Phelps employed the use of Short Interval Production Scheduling [SIPS] to manage the construction of the classroom towers at T.C. Williams High School. In SIPS, the schedule activities are established through a detailed investigation of the construction processes and building layout. The building is zoned into manageable construction blocks through which the trades flow in a sequence and predetermined unit of time. Crews are balanced based on the duration required to complete individual activities within the designated blocks. SIPS is effective in highly repetitive structures. T.C. Williams was divided into seven areas, three of which were subdivided into blocks to facilitate SIPS **(see Table 1)**. Refer to **Appendix B** for a detailed project schedule.

T.C. WILLIAMS CONSTRUCTION AREAS		
AREA	**DESCRIPTION**	**SIPS**
1	NE Tower	✓
2	Center Court	
3	NW Tower	✓
4	Kitchen Wedge	✓
5	Gym Wing	
6	Mechanical / Electrical Wedge – Auto Strip	
7	Auditorium	

Table 1. Scheduling Areas for T.C. Williams High School

c. Site Layout Planning :

Refer to the site plan, in **Appendix E,** for the location of existing and new site utilities as well as the plan for public and construction traffic flow. With the student parking being so far from the existing school building, there is an increased level of pedestrian traffic around the site. Jersey barriers were set up in higher risk areas to direct the pedestrian flow and provide a safe lane for students to walk to the existing facility. These areas include a stretch along King Street at the North end of the construction site and on the one way portion of Chinquapin Drive near the contractor staging area where it is necessary for pedestrians to share a section of the road with vehicular traffic.

The construction workers are instructed to park at the east end of Chinquapin Drive. Students that drive to school are also granted parking privileges in the same location. Student and construction parking are separated into two designated areas. Construction foreman are permitted to park beside the office trailers on site.

Access to the site can be obtained through any of the five gates in the site fence. The two gates along King Street are primarily for steel and concrete deliveries while the majority of construction materials are delivered through the main staging area gate at the entrance to the Chinquapin Drive loop. Trucks either exit through the gate from which they entered or drive though the staging area and exit onto the one-way Chinquapin Drive loop. Limited access roads are provided for contractors to move materials around the East and South sides of the structure.

The work flow for the erection of the superstructure commences in the kitchen wedge (Area 4) and progresses through the auditorium (Area 7) and along the Northwest classroom tower. Concurrently, the masons are constructing the CMU load bearing walls in the gymnasium and auto/mechanical/electrical wings (Areas 5 and 6 respectively). Afterwards, the steel joists are set in areas 5 and 6 and the erection of steel continues through the Northeast classroom tower (Area 1). Area 2 (the center court) contains the final sequences of the superstructure erection. The mobile crane was able to perform the majority of its structural steel picks from within the unobstructed center court area. As area 2 is constructed, the crane can back its way out from between the classroom towers as it positions the final steel members of the superstructure. Refer to the site layout plan **(Appendix F)** for clarification on the superstructure phase of work and traffic flow.

At the Northwest corner of the Northwest classroom tower, a concrete pump has been set up to ensure the ease of access for concrete trucks. Since the construction of Area 3 starts at the South side of the tower, the concrete is pumped along the structure and rises at the Southwest corner of the tower. Due to the long run of pipe, a relay pump may be required to force the concrete to the third floor for placement. The portable toilets and dumpsters have been strategically located on site to accommodate the construction personnel while maintaining their accessibility for waste removal trucks. Also, the man and materials hoist has been setup to provide a vertical form of transportation to an arterial corridor on second and third floors that runs East to West along the Area 1, 2, 3, 4, and 7 boundary lines out into the section of the gymnasium wing (Area 5) that occupies multiple stories.

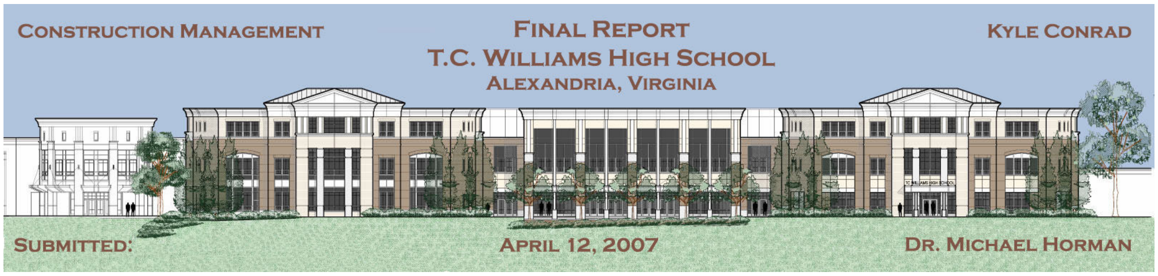
D. Proposal :

a. Critical Issues Research:

Effectiveness of Building Information Modeling [BIM] in Value Engineering [VE], Work Sequencing, and Site Logistics:

Issue:

The development of Building Information Modeling is slow to gain acceptance into the building construction industry. Recently, the General Services Administration [GSA] has mandated that all the new construction projects designed by its Public Building Services, starting in the 2007 fiscal year, are required to utilize BIM in the design phase of the project. After attending the discussion sessions at the 2006 PACE Roundtable and first hand interviews with prominent companies in the industry, a broad spectrum of company knowledge of BIM has become evident. A few companies have advanced to the point where the majority of their projects capitalize on BIM tools from start to finish while others acted as though they were hearing about BIM for the first time.



Until the benefits of BIM are clearly understood and accepted by industry professionals, hesitation to implement the process will exist and construction projects will continue to incur unnecessary rework costs.

Methods of Analysis:

Harnessing the knowledge of the Penn State Architectural Engineering faculty members, recent graduates, current students, and industry professionals interested in the development of the virtual design of construction projects, a building information model will be developed, with BIM software, in order to perform and present the technical analyses, inevitably expressing the effectiveness of BIM in these construction processes.

Expectations:

By researching, developing, and presenting the potential benefits of BIM in processes of value engineering, work sequencing, and site logistics, the exposure of industry members to the effectiveness of BIM in the construction of a project will aid in alleviating some of the hesitation of implementing BIM into their own projects. While the acceptance of BIM into the construction industry will not come overnight, graduating college students that have had experience with BIM pose to be the greatest source of opportunity for construction industry companies to enter into the new era of construction.

b. Analysis # 1: Alternative Building Materials to CMU

Issue:

School facilities commonly use CMU as a building material due to its durable characteristics and low material cost. However, the installation of CMU is extremely labor and time intensive and is less than aesthetically pleasing. Research into alternative building materials will be performed to obtain suitable selections for value engineering, constructability, and schedule reduction analyses. Value engineering is often confused with cost cutting. In actuality, VE aims to provide the owner with the best product for the amount of money allocated.

Methods of Analysis:

Materials will be analyzed against cost, schedule impacts, heat transfer, sustainability, and quality. Material costs are dependent on initial costs as well as schedule delays due to the availability of the material and labor.

Transportation costs may increase the cost of the material if the manufacturer or supplier is removed from the area where the facility is being constructed. The erection speed of the material can have a significant impact on labor savings unless the subcontractors selected to perform the work are unfamiliar with the material, resulting in a substantial learning curve. Cost savings can be acquired through a reduction of heating costs with materials that have a higher resistance to heat transfer. Since the Alexandria City Public Schools are interested in constructing a building that has a low impact on the environment, the sustainability of the materials will be considered. Interest will be expressed in materials that would improve the quality of the students' learning environment while maintaining the durability obtained with CMU.

BIM will be utilized to demonstrate the ease of performing an alteration to the original contracted model as well as quantity takes-offs for the estimate comparison between materials. Schedule impacts will also be considered and displayed in the model.

Expectations:

After a detailed investigation into alternative building material, a prefabricated material will be discovered that will promote an elegant, acoustically satisfying gymnasium in which school will be proud to host guests to the school for sporting events and assemblies. The redesigned facility will be within the original contracted budget of the facility. The materials will require less labor and time to erect and provide a more aesthetically pleasing environment to enhance the education of the students while maintaining the durability inherent in CMU.

c. Analysis # 2: Gymnasium Acoustics

Issue:

High quantities of sound absorbing materials were added to reduce the level of noise in the CMU enclosed space.

Methods of Analysis:

In continuation of the analysis performed researching alternative building materials, an acoustical analysis of the gymnasium will be performed. A new acoustical design will be developed and a detailed analysis of the room absorption will be calculated to acquire the optimum reverberation time for a high school gymnasium.

Expectations:

By selecting a material with sound absorbing characteristics, value would be added to the space with the potential of saving money by reducing the need for additional sound panels. However, a material with poorer absorption coefficients may require additional sound absorbing materials to reduce the reverberation time to the initial design, adding cost to the project.

d. Analysis # 3: Work Sequencing and Site Logistics

Issue:

Due to the extensive concrete block work in the gymnasium, automotive strip, kitchen, and auditorium the CMU wall construction begins in the early phases and continues long into the project duration. The material storage and staging area is in the far Southeastern corner of the site and all of the work is progressing in a Southeast to Northwest direction **(described in detail in Section C. c.)**. The flow of work makes transportation of building materials toward the end of the project more congested.

Methods of Analysis:

Using the alternative building materials selected in analysis #1, the flow of work will be analyzed. BIM software will be used to develop and visualize the re-sequencing of schedule activities by detecting improper sequencing of work activities as the duration of the alternative building materials are integrated into the design of the facility.

Expectations:

With the quicker erection time of prefabricated materials, the work activities in the aforementioned areas will not be require to begin as early in the construction process. Successful re-sequencing of work activities will allow for easier access to the material storage and staging areas. Ultimately, the site congestion due to the transportation of building materials will be alleviated.

e. Weight Matrix:

During the course of the Spring 2007 semester, the technical analyses discussed above will be developed and incorporated with the Building Information Model. The predicted breakdown of my allocation of time and efforts has been provided in **Table 2** below.

DESCRIPTION	RESEARCH	VALUE ENGINEERING	CONSTRUCTABILITY REVIEW	SCHEDULE REDUCTION	TOTAL
Alternative Materials	10 %	10 %	5 %	10 %	35 %
Auditorium Acoustics	5 %	10 %	0 %	0 %	15 %
Sequencing & Site Logistics	0 %	5 %	10 %	5 %	20 %
BIM	5 %	10 %	5 %	10 %	30 %
Total	**20 %**	**35 %**	**20 %**	**25 %**	**100 %**

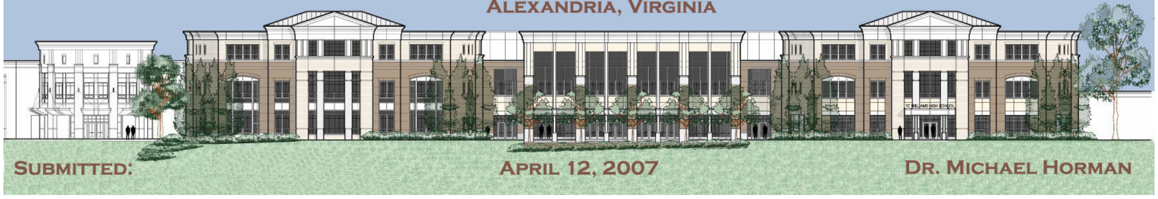
Table 2. Allocation of Time for the Spring 2007 Semester

E. Material Research :

The ultimate goal was to discover an alternative building material to CMU that would provide superior structural, thermal, and acoustical properties while maintaining the durability provided by CMU and reducing the erection time. After initial research, two products were selected for further analysis. The Aerated Concrete Corporation of America [ACCOA] manufactures an autoclave aerated concrete wall panel system that provides a superior thermal resistance and noise reduction coefficient to CMU but has a weaker compressive strength. Compared to CMU's thermal resistance of 1.11 (hr ft^2 ^{o}F)/BTU, the 7.14 (hr ft^2 ^{o}F)/BTU of the ACCOA panel shows potential. Furthermore, autoclave aerated concrete generates a noise reduction coefficient of 0.15 while the CMU lags with an NRC of 0.05. However the structural compressive strength is a concern. The T.C. William High School is designed to the 1500 psi compressive strength of CMU and the ACCOA only has a compressive strength of 580 psi and is comparable in thickness to the CMU. Significant structural redesigns would have to be considered.

The panels are available in maximum lengths of 20 feet, substantially longer the CMU. The other major concern was the panel's maximum width of 24 inches and thickness of 12 inches. While the company claims that the erection time is significantly less than CMU, the erection sequence is too similar to CMU to provide the flexibility in schedule that is of interest to the T.C. Williams High School Replacement Project.

Tri-State Solarcrete, LLC manufactures and installs a structural insulated concrete composite wall panel that will be the focus of the remainder of the report. The President of Tri-State Solarcrete, Don Oberlin, provided case studies, reports, and design manuals as well as additional incite that could only be acquired through experience with the product. The product is structurally superior to a CMU wall system and provides substantial potential for energy efficiency. The following section provides the details of the product.



F. SOLARCRETE ™ :

a. Description :

Solarcrete is a structural insulated concrete composite wall panel that is constructed of 7 $^{1}/_{4}$” of expanded polystyrene (EPS) foam insulation surrounded by rebar and sandwiched between two 2 $^{3}/_{8}$” layers of shotcrete as shown in **Figure 8**. Shotcrete is a fiber reinforced concrete that is applied pneumatically to the exterior and interior surfaces of the insulated panels. The shotcrete bonds with the rebar to form a composite system. **Figure 9** depicts the wall panel ties of the Solarcrete System. The wall ties have been improved from their original steel version that transferred heat through the insulated wall. The new polymer alloy acts as a thermal barrier improving the energy efficiency of the wall. Plastic straps slide through the slots on the ties to band the wall panels together.

Figure 8 Solarcrete Wall Panel Sample

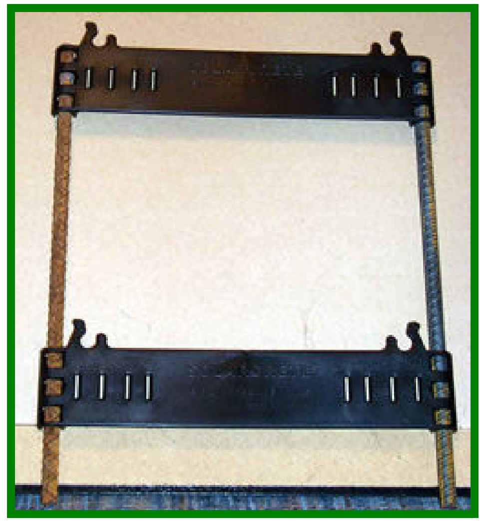


Figure 9 Solarcrete Wall Ties

Horizontal rebar snaps into the uniquely design hooks on the ties promoting improved concrete coverage. An R-value of 36 is obtained by the EPS foam insulation which provides an exceptional resistance to heat loss. The system saves on energy costs while reducing the impact on the environment by reducing the consumption of fossil fuels. Solarcrete also reduces the level of sound that is transferred through the walls. An evaluation of the wall system has revealed a Sound Transmission Class [STC] between 70 and 75. The naturally moisture resistant shotcrete effectively bonds with the EPS to form a moisture barrier. Moisture will not travel through the wall or accumulate on the interior surface of the wall. The system creates an environment that is not conducive to the growth of mold.

b. Construction Sequence :

i. Panel Fabrication :

The insulated panels are fabricated in a controlled environment before being transported to site as in **Figure 10**. Off-site fabrication reduces site congestion and the controlled environment increases worker productivity. The composite shear wall ties are spaced 2'o.c. horizontally and vertically forming a 2' x 2' grid on both sides of the wall as the plastic strips band the panels together. The EPS foam insulation panels are reinforced with #3 grade 60 rebar. The vertical reinforcement bars run the entire height of the wall through the wall ties every 2' on both sides of the wall. Horizontal reinforcing rebar are clamped into the ties at 2' increments on alternating sides of the wall. Therefore, the horizontal reinforcement will appear to be at 4'o.c. when viewed from one side of the wall. Vertical control joints are installed on both sides of the wall at a maximum of 8'o.c. and at the corners of wall openings. The control joints are fastened to the horizontal reinforcement bars with wire ties.

Figure 10 Prefabrication of EPS Panels

ii. Transportation :

The panels are sequenced and loaded onto a trailer for transportation to the jobsite as **Figure 11** portrays. Just-in-time delivery practices can be implemented to reduce the need for on-site material storage areas and the inefficiency of double handling of materials.

Figure 11 Prefabricated Panels are Loaded for Delivery to Jobsite

iii. Steel Frame Erection :

Don Oberlin, the sales representative with Tri-State Solarcrete, assures me that the Solarcrete System is structurally superior to a CMU wall. High wall assemblies sometimes require a structural steel support frame to aid in the resistance of lateral loading as **Figure 12** demonstrates. Wind can cause significant loading on higher walls. Oberlin claims that the frame also makes the task of erecting the prefabricated panels simpler by providing a means to secure the panels while they are being permanently anchored.

Figure 12 Erection of Structural Steel Support Frame

iv. Panel Erection :

The lightweight prefabricated panels are generally laid flat on the ground in the proper sequence and tilted-up into their permanent location with a boom lift or crane. **Figure 13** and **Figure 14** show a boom lift tilting-up prefabricated EPS panels. The panels are anchored directly into the strip footing eliminating the need for additional foundation walls. **Figure 15** captures an EPS panel being lowered onto a strip footing. Before the footing is poured, 42” #3 dowels are bent at 8” into ‘L’ shapes and placed at 2’ o.c. to align with the wall ties of the prefabricated EPS panels. The 32” length of the dowel protrudes from the poured footing and is wire tied to the wall tie on the EPS panel at the second vertical tie.

Figure 13 Boom Lift Tilting-up an EPS Panel

Figure 14 Boom Lift Maneuvering an EPS Panel into Place

Figure 15 Anchoring Panels to Footers

v. Shotcrete Application :

Shotcrete technology allows for the installation of structural concrete without the labor intensive formwork process and enables curvilinear designs to be constructed at an economical cost. 4000 psi fiber reinforced concrete is sprayed with an air pressurized hose and screeded to a thickness of 2 $^3/_8$" on both sides of the reinforced EPS panels as **Figure 16** and **Figure 17** show. The application of the shotcrete gives the Solarcrete Wall Panels their structural integrity as it encases the rebar to generate a composite wall system.

Figure 16 Application of Shotcrete

Figure 17 Application of Shotcrete

vi. Finish Concrete Surface :

While the most common Solarcrete exterior wall finish is acrylic stucco which the finishers are applying in **Figure 18**, the owner is not limited to a stucco finish. Face brick has been secured to the Solarcrete wall system to give the building a traditional appearance. The interior shotcrete surface is typically finished with an elastomeric or an acrylic paint, but for durability issues, higher quality finish materials are recommended for the exterior surface.

Figure 18 Finishing of Shotcrete Surface

G. Acoustical Analysis of Current Gymnasium Construction :

The current gymnasium design consists of ground face CMU load bearing walls, athletic wood flooring, and an acoustical metal roof deck as the interior surfaces. Acoustic CMU is specified for approximately 3,750 sf of the bearing walls and wooden bleachers cover 2,626 sf of wall area on the North and South ends of the gymnasium. When extended, the bleachers cover 12,584 sf of the floor area as well. The East and West elevations of the current design can be found in drawing A-400 in **Appendix J**. Only the East and West elevations were drafted since the North and South elevations will not be effected by any of the redesign options. After discovering the materials specified by the architect, the manufacturers were contacted to obtain the correct sound absorption coefficients presented in **Table 3**. Generic material properties were acquired from *Architectural Acoustics,* by M. David Egan, for unspecified materials. Reverberation time calculations were performed to ensure that speech perception would be acceptable for audience members attending indoor sporting events or school assemblies. The open gymnasium was analyzed with the bleachers retracted, ¾ occupancy and full occupancy to compare the possible reverberation times. All calculations were performed for the full volume of the space since the divider curtains are constructed of mesh material that would allow sound to pass through freely and would only be used to divide the gymnasium during non-critical speech intelligibility events like physical education classes and would have minimal impacts on reverberation of the space. The M^C Squared System Design Group, Inc. recommends a target reverberation time of 1.5 to 1.8 seconds for a gymnasium that may be used for teaching purposes. The electronic report contains sound files linked below that demonstrate speech perception at 2 seconds and 5 seconds:

2 Seconds   5 Seconds

MATERIAL	SOUND ABSORPTION COEFFICIENTS						
	125Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	NRC
Soundblock®							
4" Type A Surface: Painted	0.12	0.85	0.36	0.36	0.42	0.45	0.50
10" Type RSC/RF Surface: Painted	0.18	0.64	1.02	0.72	0.80	0.58	0.80
Acousta-Wal®							
4" Type I Surface: Painted	0.18	0.82	0.40	0.35	0.43	0.36	0.50
10" Type IVRF Surface: Painted	0.21	0.78	0.97	0.80	0.68	0.73	0.80
Soft Sound™							
Impact Resistant 1" Fabric Acoustic Panel	0.31	0.55	0.89	1.07	1.05	1.15	0.90
Impact Resistant 2" Vinyl Acoustic Panel	0.28	0.69	1.07	1.11	1.06	1.08	1.00
Noise STOP Fabrisorb™							
High Impact Resistant 1-1/8" Fiberglass core / Fabric Facing	0.09	0.50	0.99	1.13	1.08	0.96	0.95
High Impact Resistant 2-1/8" Fiberglass core / Fabric Facing	0.45	0.91	1.09	1.14	1.02	0.98	1.05
High Impact Resistant 1-5/8" Fiberglas core / Vinyl Facing	0.23	0.64	1.16	1.16	1.14	1.02	1.05
Misc. Materials							
Concrete Block, Painted	0.10	0.05	0.06	0.07	0.09	0.08	0.05
Concrete, Rough	0.01	0.02	0.04	0.06	0.08	0.10	0.05
Concrete, Troweled	0.01	0.01	0.02	0.02	0.02	0.02	0.00
Acoustical Metal Roof Deck*	0.14	0.36	0.89	0.95	0.53	0.34	0.70
Wood parquet on Concrete	0.04	0.04	0.07	0.06	0.06	0.07	0.05
Steel Doors	0.05	0.10	0.10	0.10	0.07	0.02	0.10
Metal / Wood Seat - Unoccupied	0.15	0.19	0.22	0.39	0.38	0.30	0.30
Students, Informally Dressed Seated in Wood Chairs	0.30	0.41	0.49	0.84	0.87	0.84	0.65
Leather-Covered Upholstered Seats, Unoccupied	0.44	0.54	0.60	0.62	0.58	0.50	0.59
Glass, Ordinary Windows	0.35	0.25	0.18	0.12	0.07	0.04	0.15

* Acoustical Information obtained from Vulcraft Steel Roof and Floor Deck Catalog – 3NA, 3NIA Acoustical Deck (http://itecsteel.com/images/pdf/vulcraft_steel_deck.pdf)

Table 3 Sound Absorption Coefficients of the Gymnasium Materials

Table 4 depicts the results of the ¾ occupancy calculations of the current gymnasium design which proves to be the critical calculations for comparison in the redesign. The results reveal a reverberation time of 1.16 seconds at 500 Hz and 1.00 second at 1000 Hz which is far below the recommended target values. The reverberation calculations for the retracted bleachers and full occupancy analyses of the current gymnasium design appear in **Appendix H**.

Reverberation Time Calculator

$$T_{60} = .05(V/a) = .05(V/\sum S\alpha)$$

Reverberation Time Calculation for :	T.C. Williams High School Main Gymnasium Open Gym - 3/4 Occupancy					
CMU Walls	King Street - Alexandria, VA					
			Absorption Coefficient		Sα	
Surface	Material	Area (ft²)	500 Hz	1000 Hz	500 Hz	1000 Hz
Floor	Athletic Wood Flooring	11,979.00	0.07	0.06	838.53	718.74
Floor	3/4 Students, On Bleachers	9,438.00	0.49	0.84	4624.62	7927.92
Floor	1/4 Wood Bleachers	3,146.00	0.22	0.39	692.12	1226.94
Ceiling	3" Deep Acoustical Roof Deck	24,563.00	0.89	0.95	21861.07	23334.85
North Wall	Ground Face CMU - Painted	1,365.33	0.06	0.07	81.9198	95.5731
North Wall	3/4 Students, On Bleachers	1,969.50	0.49	0.84	965.055	1654.38
North Wall	1/4 Wood Bleachers	656.50	0.22	0.39	144.43	256.035
North Wall	Metal Doors	42.00	0.10	0.10	4.2	4.2
South Wall	Ground Face CMU - Painted	1,323.33	0.06	0.07	79.3998	92.6331
South Wall	3/4 Students, On Bleachers	1,969.50	0.49	0.84	965.055	1654.38
South Wall	1/4 Wood Bleachers	656.50	0.22	0.39	144.43	256.035
South Wall	Metal Doors	84.00	0.10	0.10	8.4	8.4
West Wall	Ground Face CMU - Painted	4,315.78	0.06	0.07	258.9468	302.1046
West Wall	Acoustical CMU	1,872.66	1.02	0.72	1910.113	1348.315
West Wall	Metal Doors	168.00	0.10	0.10	16.8	16.8
West Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
West Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
East Wall	Ground Face CMU - Painted	4,105.78	0.06	0.07	246.3468	287.4046
East Wall	Acoustical CMU	1,872.66	1.02	0.72	1910.113	1348.315
East Wall	Metal Doors	378.00	0.10	0.10	37.8	37.8
East Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
East Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
					0	0
					0	0
					0	0
Room Length (ft):	203.00	ft	$a = \sum S\alpha$		35178.95	40957.28
Room Width (ft):	121.00	ft	$T_{60} = .05(V/\sum S\alpha)$		1.16	1.00
Room Height (ft):	33.33	ft				
Volume (ft³):	**818,685**	ft³				
Target Reverberation Time: Gymnasium for Teaching*					1.5 to 1.8	1.5 to 1.8

* Target Reverberation Time obtained from the M² Squared System Design Group, Inc.

Table 4 Reverberation Time Calculations for ¾ Occupancy of the Current Gymnasium Design

H. Proposed Acoustical Redesign of Gymnasium :

Although the current design performs better than the recommended reverberation times, the redesigned gymnasium displayed in **Table 5** will seek to obtain a reverberation time equivalent to the current design in case unknown design factors were considered in the original design. Refer to **Appendix H** for all reverberation time calculations for the various gymnasium designs. The interior surface of the Solarcrete system is more sound reflective than the CMU walls and required the addition of sound absorbing materials to reduce the noise in the space and improve the speech perception of the space. Several manufacturers of acoustical wall panels were researched to select a product suitable to the gymnasium. High impact resistant panels were selected from two manufacturers to be applied to the redesign process of the gymnasium and compared in **Table 3**. The Acoustic Product Division of the American Micro Industries, Inc. out of Chambersburg, PA manufacturers a large line of SOFT SOUND™ acoustic wall panels. Their proximity to the D.C. area would reduce delivery costs and transportation time. The impact resistant model is recommended for areas of high probability of impact to ensure the panels are not damaged and unable to perform acoustically. The 1 in thick fabric panel was used as one of the design options for the gymnasium and appears in the gymnasium elevations drawing A-402 in **Appendix J**.

Acoustical Surfaces, Inc. based in Chaska, MN manufactures a similar line of acoustical wall panels marketed under the name FABRISORB™. These products were ultimately selected in the redesign of the T.C. Williams High School Main Gymnasium due to their superior performance and the eagerness of their salesman, Ted Weidman, to assist in the development of a quote and additional product information. The product specifications for these wall panels are included in **Appendix K** along with the official quote. An electronic version of the specifications is also available from their company website (http://www.acousticalsurfaces.com/fabric_panel/fpswallp.htm). Initially, the gymnasium was redesigned using the 1-5/8" vinyl covered impact resistant panels. After corresponding with Weidman, the 1-1/8" fabric panels proved to be more economical. The redesign resulted in the design presented in drawing A-401 of the gymnasium elevations, **Appendix J**. The addition of 4,320 sq ft of the 1-1/8" FABRISORB™ wall panels, required by the calculation shown in **Table 6**, will cost a total of $34,970.80 for the panels and installation accessories. A breakdown of the quote is available in **Table 7**. Since the material supplier is located in Minnesota, the delivery costs will be substantially higher than if the Pennsylvania based manufacturer was selected and could potentially have a negative impact on the lead time of the products.

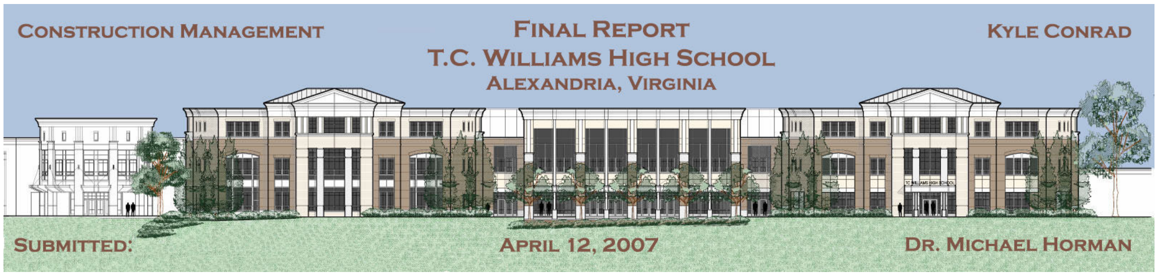
Reverberation Time Calculator

$$T_{60} = .05(V/a) = .05(V/\sum S\alpha)$$

Reverberation Time Calculation for:		T.C. Williams High School Main Gymnasium				
Solarcrete System - w/o Acoustic Wall Panels		Open Gym - 3/4 Occupancy King Street - Alexandria, VA				
			Absorption Coefficient		Sα	
Surface	Material	Area (ft²)	500 Hz	1000 Hz	500 Hz	1000 Hz
Floor	Athletic Wood Flooring	11,979.00	0.07	0.06	838.53	718.74
Floor	3/4 Students, On Bleachers	9,438.00	0.49	0.84	4624.62	7927.92
Floor	1/4 Wood Bleachers	3,146.00	0.22	0.39	692.12	1226.94
Ceiling	3" Deep Acoustical Roof Deck	24,563.00	0.89	0.95	21861.07	23334.85
North Wall	Concrete, Troweled	1,365.33	0.02	0.02	27.3066	27.3066
North Wall	3/4 Students, On Bleachers	1,969.50	0.49	0.84	965.055	1654.38
North Wall	1/4 Wood Bleachers	656.50	0.22	0.39	144.43	256.035
North Wall	Metal Doors	42.00	0.10	0.10	4.2	4.2
South Wall	Concrete, Troweled	1,323.33	0.02	0.02	26.4666	26.4666
South Wall	3/4 Students, On Bleachers	1,969.50	0.49	0.84	965.055	1654.38
South Wall	1/4 Wood Bleachers	656.50	0.22	0.39	144.43	256.035
South Wall	Metal Doors	84.00	0.10	0.10	8.4	8.4
West Wall	Concrete, Troweled	6,188.44	0.02	0.02	123.7688	123.7688
West Wall	Metal Doors	168.00	0.10	0.10	16.8	16.8
West Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
West Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
East Wall	Concrete, Troweled	5,978.44	0.02	0.02	119.5688	119.5688
East Wall	Metal Doors	378.00	0.10	0.10	37.8	37.8
East Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
East Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
					0	0
					0	0
					0	0
					0	0
					0	0
Room Length (ft):	203.00	ft	a = ∑Sα		30989.22	37780.04
Room Width (ft):	121.00	ft	$T_{60} = .05(V/\sum S\alpha)$		1.32	1.08
Room Height (ft):	33.33	ft				
Volume (ft³):	818,685	ft³				
Target Reverberation Time: Gymnasium for Teaching*					1.5 to 1.8	1.5 to 1.8

* Target Reverberation Time obtained from the M^{c} Squared System Design Group, Inc.

Table 5 Reverberation Time Calculations for ¾ Occupancy of the Solarcrete Gymnasium Redesign



Reverberation Time Calculator

$T_{60} = .05(V/a) = .05(V/\sum S\alpha)$

Reverberation Time Calculation for :		T.C. Williams High School Main Gymnasium Open Gym - 3/4 Occupancy				
Solarcrete System - w/ Fabrisorb™ Acoustic Wall Panels		King Street - Alexandria, VA				
			Absorption Coefficient		$S\alpha$	
Surface	Material	Area (ft^2)	500 Hz	1000 Hz	500 Hz	1000 Hz
Floor	Athletic Wood Flooring	11,979.00	0.07	0.06	838.53	718.74
Floor	3/4 Students, On Bleachers	9,438.00	0.49	0.84	4624.62	7927.92
Floor	1/4 Wood Bleachers	3,146.00	0.22	0.39	692.12	1226.94
Ceiling	3" Deep Acoustical Roof Deck	24,563.00	0.89	0.95	21861.07	23334.85
North Wall	Concrete, Troweled	1,365.33	0.02	0.02	27.3066	27.3066
North Wall	3/4 Students, On Bleachers	1,969.50	0.49	0.84	965.055	1654.38
North Wall	1/4 Wood Bleachers	656.50	0.22	0.39	144.43	256.035
North Wall	Metal Doors	42.00	0.10	0.10	4.2	4.2
South Wall	Concrete, Troweled	1,323.33	0.02	0.02	26.4666	26.4666
South Wall	3/4 Students, On Bleachers	1,969.50	0.49	0.84	965.055	1654.38
South Wall	1/4 Wood Bleachers	656.50	0.22	0.39	144.43	256.035
South Wall	Metal Doors	84.00	0.10	0.10	8.4	8.4
West Wall	Concrete, Troweled	6,188.44	0.02	0.02	123.7688	123.7688
West Wall	Metal Doors	168.00	0.10	0.10	16.8	16.8
West Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
West Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
East Wall	Concrete, Troweled	5,978.44	0.02	0.02	119.5688	119.5688
East Wall	Metal Doors	378.00	0.10	0.10	37.8	37.8
East Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
East Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
					0	0
West Wall	1-1/8" Fabric Impact Resistant Acoustic Panels	2,160.00	0.99	1.13	2138.4	2440.8
East Wall	1-1/8" Fabric Impact Resistant Acoustic Panels	2,160.00	0.99	1.13	2138.4	2440.8
					0	0
					0	0
Room Length (ft):	203.00	ft	$a = \sum S\alpha$		35266.02	42661.64
Room Width (ft):	121.00	ft				
Room Height (ft):	33.33	ft	$T_{60} = .05(V/\sum S\alpha)$		1.16	0.96
Volume (ft^3):	818,685	ft^3	CMU Reverberation Time		1.16	1.00
Target Reverberation Time: Gymnasium for Teaching*					1.5 to 1.8	1.5 to 1.8

* Target Reverberation Time obtained from the M² Squared System Design Group, Inc.

Table 6 Reverberation Time Calculations for ¾ Occupancy of the Gymnasium Redesign using 1-1/8" FABRISORB™ Acoustic Wall Panels

Acoustic Panel Quote				
Acoustical Surfaces, Inc.				
Item	Quantity	Units	Unit Price*	Cost
Fabrisorb 1-1/8" High Impact Fabric Wrapped Panels	4,320	sf	7.59	$32,788.80
Impaling Clips (10 per panel)	1,200	each	0.50	$600.00
PSA-29 Acoustical Panel Adhesive Tubes	144	each	9.25	$1,332.00
Packing/ Plywood Crating	2	each	125.00	$250.00
			Total:	$34,970.80

Note:
* Based on Quote Compiled by Ted Weidman on 5/11/2007 on 3,600sf of 4' x 9' panels

Table 7 1-1/8" FABRISORB™ High Impact Resistant Acoustic Wall Panel Quote

I. Heat Transfer :

In order to satisfy the school district's desire to construct an energy efficient building and continue the value engineering exercise, a heat transfer analysis was performed to compare the heating and cooling energy losses of the facility under the current CMU design and the proposed Solarcrete system. The designs were analyzed for the winter and summer months. Thermal gradients were sketched to express the contributions of each building element in the resistance to energy loss through the wall systems. The magnitude of the slope of the line through the cross section of the wall system corresponds to the material's degree of resistance to heat loss when compared to the other components of the wall system.

Equation Eq-1 was used to obtain the rate of heat flux through the wall assemblies.

$$Q'' = \frac{T_h - T_c}{1/h_h + R_1 + R_2 + R_i + 1/h_c} \qquad \text{(Eq-1)}$$

Exterior temperatures were obtained for the Alexandria, Virginia area from the 2004 edition of the *ASHRAE Fundamentals Handbook of Weather Data* and the interior temperatures were acquired from the Equipment Schedule M0.2 from the T.C. Williams High School construction drawing set. The material R-values were obtained from Dougal Drysdale's *Introduction to Fire Dynamics* and Faye McQuiston's *Heating, Ventilating, and Air Conditioning Analysis and Design* for the CMU wall assembly and the shotcrete components of the Solarcrete system. The data for the EPS panels in the Solarcrete wall system was taken from technical data sheets supplied by Tri-State Solarcrete, LLC. After performing the heat flux calculations for each system, the results proved that the Solarcrete wall system is over three times more efficient than the CMU wall system. The current CMU wall system allows 5.25 BTU/(hr ft^2 ^oF) of heat energy to transfer through the wall during the winter and 1.80 BTU/(hr ft^2 ^oF) during the summer. Meanwhile, the Solarcrete wall system only permits 1.60 BTU/(hr ft^2 ^oF) to transfer in the winter and 0.55 BTU/(hr ft^2 ^oF) in the summer.

Equation Eq-2 was used to determine the temperature difference on each side of a material within each wall assembly in both the winter and summer. When used sequentially from inside to outside, or vise versa, the exact temperature can be determined on each face of the wall components. **Table 8** and **Table 9** show the calculations run to determine the temperatures between the building materials of the CMU wall assembly shown in the thermal gradients in **Figure 19** and **Figure 20** for the winter and summer analyses respectively. Likewise **Table 10** and **Table 11** apply to the Solarcrete system walls in the thermal gradients in **Figure 20** and **Figure 21**.

$$T_x - T_y = Q'' (R_x) \qquad \text{(Eq-2)}$$

Carrier's Hourly Analysis Program was utilized to run a full scale energy calculation to determine the additional amount of energy required to operate the supply fans and cooling system to compensate for the energy loss of the building through the main gymnasium walls. **Figure 23** displays the results of the analysis. An annual cost savings of $3,296 results in a total of $9,888 for all the three rooftop air handling units with the Solarcrete wall system over the previously designed CMU wall system. The costs are estimated off of $0.06 / kWhr energy utility costs.

HEAT TRANSFER DIAGRAM

Wall Construction: Face Brick with CMU Backup — T_{IN} = 70.00 °F
Season: Winter — T_{OUT} = 15.00 °F

Calculations:

$T_{IN} - T_1 = Q'' (R_{INT. AIR FILM})$	70.00 °F	$- T_1$ =	5.25 (0.68)	T_1 = 66.43	°F
$T_1 - T_2 = Q'' (R_{10'' CMU})$	66.43 °F	$- T_2$ =	5.25 (1.72)	T_2 = 57.40	°F
$T_2 - T_3 = Q'' (R_{1/2'' Collar Joint})$	57.40 °F	$- T_3$ =	5.25 (0.10)	T_3 = 56.88	°F
$T_3 - T_4 = Q'' (R_{8'' CMU})$	56.88 °F	$- T_4$ =	5.25 (1.11)	T_4 = 51.05	°F
$T_4 - T_5 = Q'' (R_{1\text{-}1/2'' RIGID INSULATION})$	51.05 °F	$- T_5$ =	5.25 (5.00)	T_5 = 24.80	°F
$T_5 - T_6 = Q'' (R_{3/4'' AIR SPACE})$	24.80 °F	$- T_6$ =	5.25 (1.26)	T_6 = 18.18	°F
$T_6 - T_7 = Q'' (R_{4'' FACE BRICK})$	18.18 °F	$- T_7$ =	5.25 (0.43)	T_7 = 15.93	°F
$T_7 - T_{OUT} = Q'' (R_{EXT. AIR FILM})$	15.93 °F	$- T_{OUT}$ =	5.25 (0.17)	T_{OUT} = 15.03	°F
			$\sum R$ = 10.47		

Table 8 Thermal Gradient Calculations for Gymnasium CMU Wall in the Winter

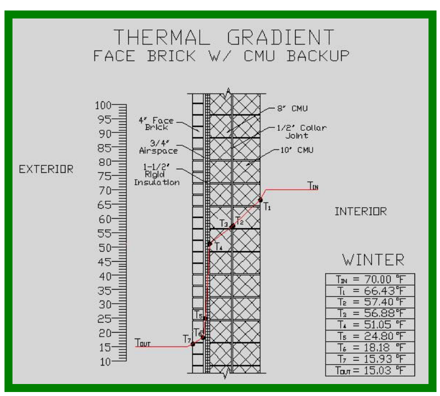


Figure 19 Thermal Gradient through CMU Gymnasium Wall in the Winter

HEAT TRANSFER DIAGRAM

Wall Construction:	Face Brick with CMU Backup				T_{IN} = 76.00 °F
Season:	Summer				T_{OUT} = 95.00 °F
Calculations:					
$T_{OUT} - T_1 = Q''(R_{EXT.\ AIR\ FILM})$	95.00 °F	$- T_1$	=	1.80 (0.25)	T_1 = 94.55 °F
$T_1 - T_2 = Q''(R_{4''\ FACE\ BRICK})$	94.55 °F	$- T_2$	=	1.80 (0.43)	T_2 = 93.78 °F
$T_2 - T_3 = Q''(R_{3/4''\ AIR\ SPACE})$	93.78 °F	$- T_3$	=	1.80 (1.26)	T_3 = 91.51 °F
$T_3 - T_4 = Q''(R_{1\text{-}1/2''\ RIGID\ INSULATION})$	91.51 °F	$- T_4$	=	1.80 (5.00)	T_4 = 82.51 °F
$T_4 - T_5 = Q''(R_{8''\ CMU})$	82.51 °F	$- T_5$	=	1.80 (1.11)	T_5 = 80.51 °F
$T_5 - T_6 = Q''(R_{1/2''\ Collar\ Joint})$	80.51 °F	$- T_6$	=	1.80 (0.10)	T_6 = 80.33 °F
$T_6 - T_7 = Q''(R_{10''\ CMU})$	80.33 °F	$- T_7$	=	1.80 (1.72)	T_7 = 77.23 °F
$T_7 - T_{IN} = Q''(R_{INT.\ AIR\ FILM})$	77.23 °F	$- T_{IN}$	=	1.80 (0.68)	T_{IN} = 76.01 °F
				$\sum R$ = 10.55	

Table 9 Thermal Gradient Calculations for Gymnasium CMU Wall in the Summer

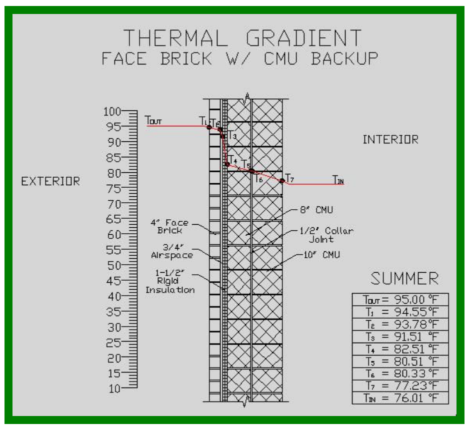


Figure 20 Thermal Gradient through CMU Gymnasium Wall in the Summer

HEAT TRANSFER DIAGRAM				
Wall Construction: Solarcrete Wall System				T_{IN} = 70.00 °F
Season: Winter				T_{OUT} = 15.00 °F
Calculations:				
$T_{IN} - T_1 = Q"$ ($R_{INT. AIR FILM}$)	70.00 °F $- T_1$	=	1.60 (0.68)	T_1 = 68.91 °F
$T_1 - T_2 = Q"$ ($R_{SHOTCRETE}$)	68.91 °F $- T_2$	=	1.60 (0.30)	T_2 = 68.43 °F
$T_2 - T_3 = Q"$ (R_{EPS})	68.43 °F $- T_3$	=	1.60 (32.95)	T_3 = 15.71 °F
$T_3 - T_4 = Q"$ ($R_{SHOTCRETE}$)	15.71 °F $- T_4$	=	1.60 (0.30)	T_4 = 15.23 °F
$T_4 - T_{OUT} = Q"$ ($R_{EXT. AIR FILM}$)	15.23 °F $- T_{OUT}$	=	1.60 (0.17)	T_{OUT} = 14.96 °F
			∑ R = 34.40	

Table 10 Thermal Gradient Calculations for Gymnasium Solarcrete Wall in the Winter

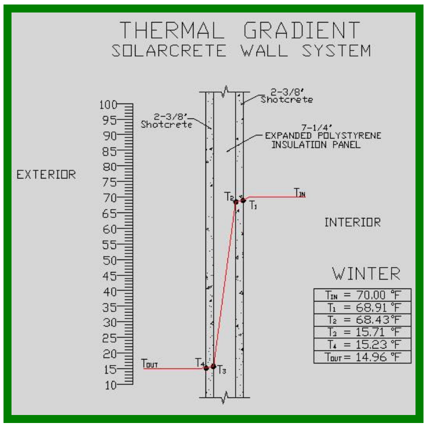


Figure 21 Thermal Gradient through Solarcrete Gymnasium Wall in the Winter

HEAT TRANSFER DIAGRAM				
Wall Construction: Solarcrete Wall System				T_{IN} = 76.00 °F
Season: Summer				T_{OUT} = 95.00 °F
Calculations:				
$T_{OUT} - T_1 = Q"$ ($R_{EXT. AIR FILM}$)	95.00 °F $- T_1$	=	0.55 (0.25)	T_1 = 94.86 °F
$T_1 - T_2 = Q"$ ($R_{SHOTCRETE}$)	94.86 °F $- T_2$	=	0.55 (0.30)	T_2 = 94.70 °F
$T_2 - T_3 = Q"$ (R_{EPS})	94.70 °F $- T_3$	=	0.55 (32.95)	T_3 = 76.58 °F
$T_3 - T_4 = Q"$ ($R_{SHOTCRETE}$)	76.58 °F $- T_4$	=	0.55 (0.30)	T_4 = 76.41 °F
$T_4 - T_{IN} = Q"$ ($R_{INT. AIR FILM}$)	76.41 °F $- T_{IN}$	=	0.55 (0.68)	T_{IN} = 76.04 °F
			∑ R = 34.48	

Table 11 Thermal Gradient Calculations for Gymnasium Solarcrete Wall in the Summer

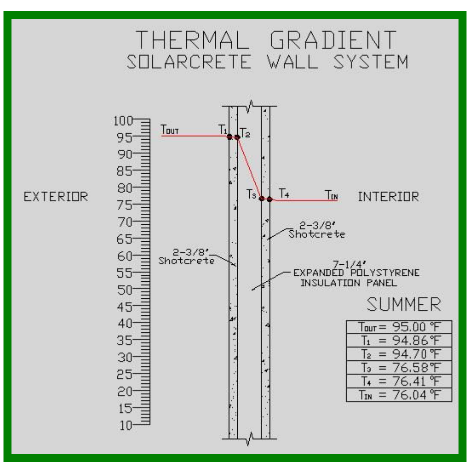


Figure 22 Thermal Gradient through Solarcrete Gymnasium Wall in the Summer

808Table 1. Annual Costs

Component	Existing School ($)	New School ($)
Air System Fans	6,832	3,522
Cooling	245	239
Heating	0	0
Pumps	0	0
Cooling Tower Fans	0	0
HVAC Sub-Total	**7,078**	**3,762**
Lights	3,575	3,575
Electric Equipment	1,655	1,655
Misc. Electric	0	0
Misc. Fuel Use	0	0
Non-HVAC Sub-Total	**5,230**	**5,230**
Grand Total	**12,308**	**8,992**

Table 2. Annual Cost per Unit Floor Area

Component	Existing School ($/ft²)	New School ($/ft²)
Air System Fans	0.278	0.143
Cooling	0.010	0.010
Heating	0.000	0.000
Pumps	0.000	0.000
Cooling Tower Fans	0.000	0.000
HVAC Sub-Total	**0.288**	**0.153**
Lights	0.146	0.146
Electric Equipment	0.067	0.067
Misc. Electric	0.000	0.000
Misc. Fuel Use	0.000	0.000
Non-HVAC Sub-Total	**0.213**	**0.213**
Grand Total	**0.501**	**0.366**
Gross Floor Area (ft²)	24563.0	24563.0
Conditioned Floor Area (ft²)	24563.0	24563.0

Note: Values in this table are calculated using the Gross Floor Area.

Table 3. Component Cost as a Percentage of Total Cost

Component	Existing School (%)	New School (%)
Air System Fans	55.5	39.2
Cooling	2.0	2.7
Heating	0.0	0.0
Pumps	0.0	0.0
Cooling Tower Fans	0.0	0.0
HVAC Sub-Total	**57.5**	**41.8**
Lights	29.0	39.8
Electric Equipment	13.4	18.4
Misc. Electric	0.0	0.0
Misc. Fuel Use	0.0	0.0
Non-HVAC Sub-Total	**42.5**	**58.2**
Grand Total	**100.0**	**100.0**

Figure 23 Carrier's HAP Analysis of Gymnasium Designs

J. Building Information Modeling [BIM] :

Building Information Modeling is slowly gaining acceptance in the construction industry. When creating a Building Information Model, the developer must ask themselves what goal they wish to achieve by building the model. The most effective model may not require intricate levels of detail. By incorporating the useless detail, time and money will be wasted and the file sizes will increase causing the model to run slower unnecessarily. Ideally, a BIM will be initiated early in the project and incorporate all aspects of design, construction, and operation and maintenance of a facility. However, the issue of interoperability between the different software packages of the team members arises. The goal of the T.C. Williams High School Model will be to quickly perform quantity take-offs, manipulate the original design for value engineering purposes, design a structural moment frame, and visualize and re-sequence the construction schedules through 4D planning of areas 5, 6, & 7. Interoperability between the Autodesk Revit software, RAM Structural Systems, and NavisWorks will be researched to develop the BIM using the software applications.

a. Autodesk Revit Building 9.1 :

The structural grid displayed in **Figure 24** was developed using Autodesk Revit Building 9.1 based on the structural construction drawings provided by Hensel Phelps. All structural drawings were referenced to accurately model areas 5, 6, & 7 of the T.C. Williams High School Replacement Project. The initial model shown in **Figure 25** was modeled with generic walls to speed the modeling process. Areas 1-4 were created as a mass model since they are beyond the limits of the project analysis.

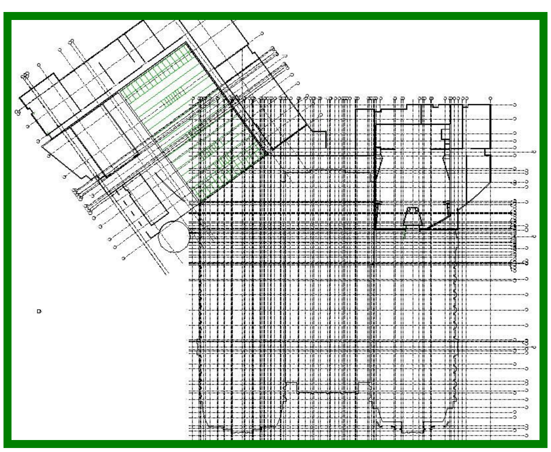


Figure 24 Autodesk Revit Building 9.1 - Structural Grid

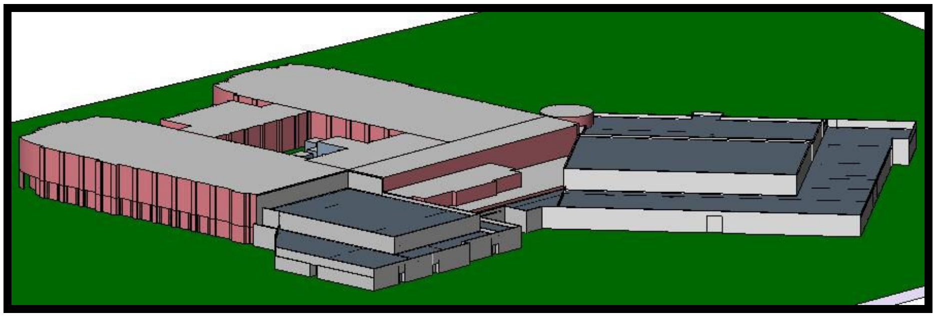


Figure 25 Autodesk Revit Building 9.1 - Generic Load Bearing Walls

After the entire model was complete, the wall types were changed from generic walls to the actual thickness of CMU designated by the structural engineers as **Figure 26** shows. The model was saved as a different file name to maintain the initial generic model. The wall types in the generic model were once again altered to convey the design of the Solarcrete Wall System shown in **Figure 27**. A wall schedule was created in both the CMU and Solarcrete models to generate a list of wall quantities to export to Microsoft Excel. Once the text files were opened in Excel, minor changes had to be made to the spreadsheet in order to create a functional spreadsheet to perform a summation of quantities and sort by wall types. When copying and pasting from the exported schedule, not all entries were automatically inserted into Excel as numbers. After manipulating the entries, quantity take-offs could be generated very easily. **Table 12** and **Table 13** provide summaries of the quantity take-offs of the wall areas of CMU and Solarcrete, respectively, for areas 5, 6, & 7 of the T.C. Williams High School facility.

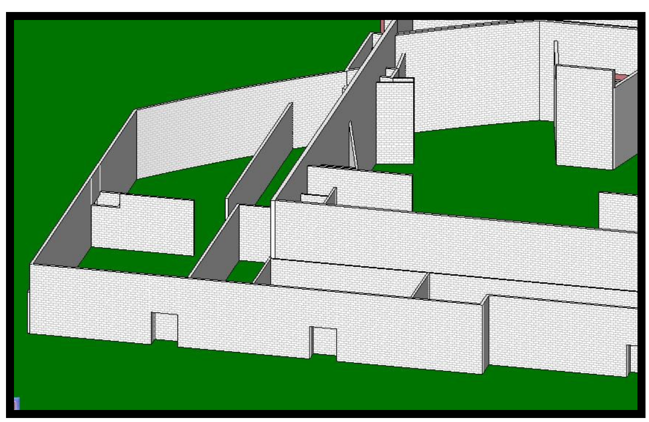


Figure 26 Autodesk Revit Building 9.1 - CMU Walls

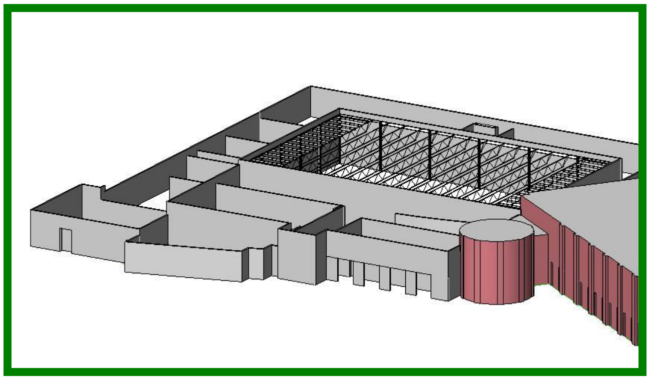


Figure 27 Autodesk Revit Building 9.1 - Solarcrete Wall System

T.C. Williams High School QTO - Current Construction		
Gymnasium		
	10" CMU	49,827 sf
	12" CMU	14,828 sf
	14" CMU	19,440 sf
	6" CMU	7,469 sf
	8" CMU	19,007 sf
	Sub-Total:	**110,571 sf**
Auditorium		
	10" CMU	19,046 sf
	12" CMU	8,281 sf
	14" CMU	13,981 sf
	6" CMU	8,661 sf
	8" CMU	10,857 sf
	Sub-Total:	**60,826 sf**
Mech/Elec Wedge - Auto Strip		
	10" CMU	16,587 sf
	6" CMU	1,625 sf
	8" CMU	5,217 sf
	Sub-Total:	**23,429 sf**
Misc.		**45 sf**
	Total:	**194,871 sf**

Table 12 Summary of Quantity Take-Off Developed from CMU Wall Schedule

T.C. Williams High School QTO - Solarcrete System		
Gymnasium		
12" Panel	66,167 sf	2,595 lf
Sub-Total:	**66,167 sf**	**2,595 lf**
Auditorium		
12" Panel	42,367 sf	1,900 lf
Sub-Total:	**42,367 sf**	**1,900 lf**
Mech/Elec Wedge - Auto Strip		
12" Panel	21,383 sf	1,220 lf
Sub-Total:	**21,383**	**1,220 lf**
Total:	**129,917 sf**	**5,715 lf**

Table 13 Summary of Quantity Take-Off Developed from Solarcrete Wall Schedule

After the structural steel moment frame is designed and modeled using Revit Structure 4 and RAM Structural Systems, the model is reloaded into either Revit Building 9.1 or Revit Structure 4 to develop structural framing and structural column schedules to export to Microsoft Excel for quantity take-offs of the structural steel involved in the construction of the moment frame to support the Solarcrete wall system in gymnasium. **Table 14** and **Table 15** provide summaries of the quantities and lengths of the structural steel members.

Structural Framing Schedule			
Count	**Family**	**Type**	**Length**
2	W-Wide Flange	W14X48	29' - 11"
3	W-Wide Flange	W24X68	36' - 0"
2	W-Wide Flange	W21X62	36' - 0"
1	W-Wide Flange	W24X68	36' - 5 15/16"
1	W-Wide Flange	W24X68	35' - 6 1/16"
2	W-Wide Flange	W12X50	29' - 11"
4	W-Wide Flange	W8X21	24' - 11"
6	W-Wide Flange	W8X18	24' - 0"
1	W-Wide Flange	W24X68	35' - 6 1/16"
14	DLH-Series Bar Joist	68DLH19	121' - 10"
30	W-Wide Flange	W12X26	23' - 11"

Table 14 Summary of Quantity Take-Off Developed from Structural Framing Schedule

Structural Column Schedule			
Count	Family	Type	Length
18	W-Wide Flange-Column	W14X145	32' - 8"
4	W-Wide Flange-Column	W10X49	32' - 8"

Table 15 Summary of Quantity Take-Off Developed from Structural Column Schedule

b. Autodesk Revit Structure 4 :

Autodesk Revit Structure 4 was used to design a generic moment frame to be analyzed and sized by RAM Structural Systems. The generic building model created in Revit Building 9.1 could be opened directly with Revit Structure 4. Additional grid lines were added to the gymnasium to make the RAM analysis easier. Grid lines were created at the location of each change in loading to allow loads to be snapped to grid intersections in the RAM software. Generic columns, beams and joists shown in **Figure 28** and **Figure 29** were designed in Revit Structure 4 due to the user friendly interface of the software. RAM International, the makers of RAM Structural System, had to be contacted to acquire a link for exporting a Revit Structure 4 model that would compatible with RAM Structural Systems. You must first register with RAM International, at http://www.ramint.com/support/revit.jsp, before they will email the link to your email address of choice. After the link is received via email, the link must be installed onto your computer. Once Autodesk Revit Structure 4 is reopened, the link will automatically appear under the Tools dropdown menu in the main toolbar. A RAM file will be saved in the same folder as the Revit file and can be directly open by RAM Structural Systems.

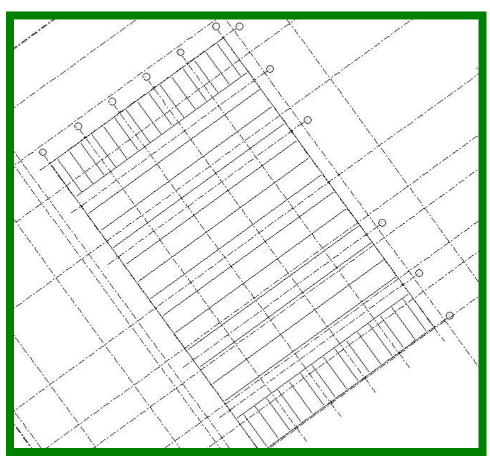


Figure 28 Generic Structural Moment Frame Created in Revit Structure 4

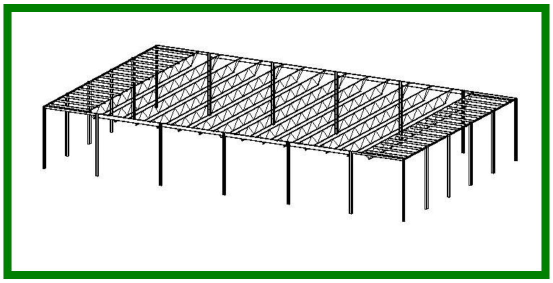


Figure 29 Revit Structure 4 - 3D model of Gymnasium Moment Frame

c. RAM Structural Systems :

RAM Structural Systems was used to apply the joist loadings specified in structural construction drawing S4-24 and the lateral wind loading. The wind loading was designed at a basic wind speed of 90 mph and exposure B. An importance factor of 1.15 was applied to the loading per the structural engineer's direction. The loads are created and applied in RAM Modeler which appears in **Figure 30**. The RAM Beams, RAM Columns, and RAM Structural Frame functions were used to analyze and size the structural members. After the frame was designed the model was saved and imported back into the Revit Structure 4 file.

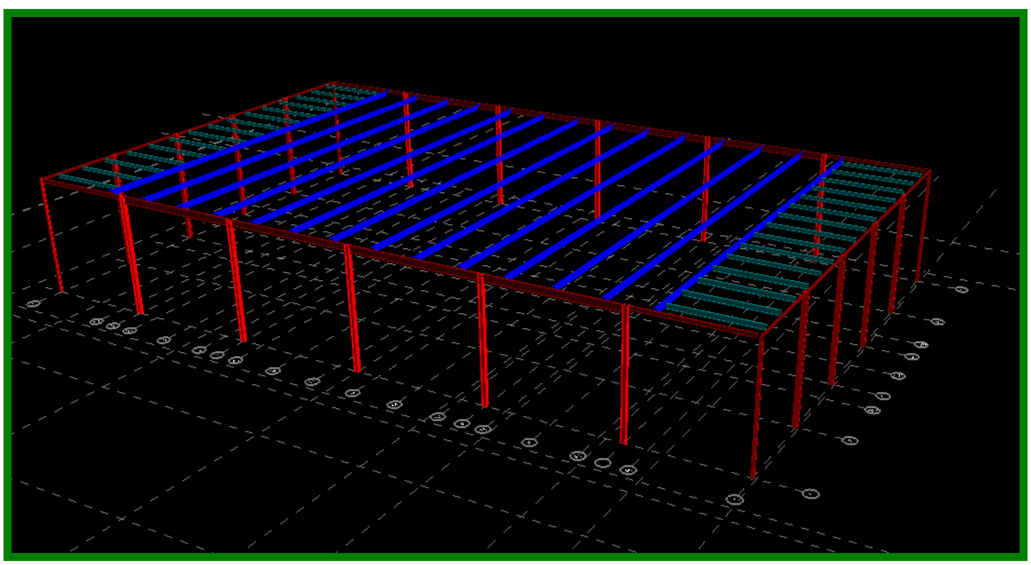


Figure 30 RAM Analysis of Structural Moment Frame

d. NavisWorks :

NavisWorks Timeliner assisted in the re-sequencing of the construction of the superstructure for the T.C. Williams High School Replacement Project. Autodesk Revit Building also contains a link to export a Revit model as a NavisWorks file under the tools dropdown menu in the main toolbar. A project schedule is linked to the NavisWorks file in the Timeliner mode from Microsoft Project or Primavera scheduling software. Microsoft Project was used for the schedule development. By attaching schedule tasks to building model components, a 4D model is generated and can be played to analyze and adjust the construction schedule. The visualization of the construction sequence allows the scheduler to notice errors in the sequence and avoid costly delays before the construction takes place in the field. A Windows Media file can be recorded to allow the 4D model to be viewed by any user with a Windows operating system.

K. Work Sequencing :

The current construction sequence of the superstructure requires that the work progress away from the material staging and storage areas as portrayed in the Superstructure Site Plan C-101 in **Appendix F**. Areas 5, 6, & 7 have an extremely large quantity of CMU load bearing walls. Since CMU construction is extremely labor and time intensive, the aforementioned areas must begin early in the structural sequencing to be completed when the steel framed towers top-out. The sequencing builds a barrier between the construction and the material staging and storage areas, creating the need for materials to be transported outside of the site fence onto a public access road due to site constraints on the East side of the site. Pedestrian traffic is also heavy along this roadway since the temporary student parking area and construction parking is located at the end of the roadway. An increased safety risk arises and additional resources will be required to flag vehicular and pedestrian traffic. Time will also be wasted transporting materials around the site and previously constructed portions of the structure.

The structural redesign schedule found in **Appendix D** reveals the schedule impacts due to the re-sequencing of the current CMU load bearing wall design and the proposed Solarcrete System. To re-sequence the current CMU design to accommodate the desired erection sequence proposed in the 4D models and the Re-Sequenced Superstructure Site Logistics Plan C-102 in **Appendix G**, the construction schedule would have to be extended by 252 work days. With the Solarcrete System, the schedule would be reduced by 17 work days. The rapid erection time of the Solarcrete system adds flexibility to the order of the construction of areas 5, 6, & 7 in the construction sequence and promotes a more efficient sequence in terms of site logistics.

L. Site Logistics Impact :

The re-sequenced construction schedule discussed in the previous section and presented in the Re-Sequenced Superstructure Site Logistics Plan C-102 in **Appendix G**, alleviates site congestion during the superstructure phase of construction. The work flow is permitted to progress toward the material staging and storage area in such a manner that extends the duration that the bulk of the construction materials can be transported to the designated areas of installation without interferences from concurrent construction.

M. Conclusions :

After reviewing the results from the Solarcrete value engineering exercise, the Solarcrete system would be a valuable solution to the proposed issues with CMU construction. **Table 16** provides a summary of the comparisons between the CMU and Solarcrete wall systems. While the initial cost of the Solarcrete wall system is approximately 15% greater than the CMU wall system, Solarcrete provides the owner with an equally durable wall system that provides exceptional energy efficiency. Further analysis could be performed to reduce the size of the air handling units and reduce the initial cost difference between the two wall systems. The Solarcrete system also provides for a safer and more efficient site by promoting an alternative sequence for the erection of the superstructure with a reduced schedule duration. The Solarcrete system outperforms the traditional CMU construction practices analyzed in terms of schedule impacts, construction labor hours, and energy efficiency.

T.C. Williams High School		
System Comparisons		
Description	**Solarcrete Construction**	**CMU Construction**
System Costs		
Solarcrete Panels	$2,057,679.00	$0.00
CMU	$0.00	$1,902,662.00
Additional Structural Steel	$132,547.00	$0.00
Fabrisorb Acoustic Wall Panels	$34,970.80	$0.00
Sub-Total:	**$2,225,196.80**	**$1,902,662.00**
Cost Difference:	**$322,534.80**	
Energy Savings		
Cost Savings on Supply Fan Load per Year	**$6,592.00**	$0.00
Heat Transfer Through Wall* - Winter	1.60 BTU/(hr ft^2)	5.25 BTU/(hr ft^2)
Heat Transfer Through Wall* - Summer	0.55 BTU/(hr ft^2)	1.80 BTU/(hr ft^2)
Schedule		
Schedule Impact**	158.5 days	695.0 days
Re-Sequenced Schedule Savings***	17 days	-252 days
Manhours		
Areas 5, 6 & 7 Labor Hours	8,979 mhrs	29,536 mhrs

Note:
* Analysis of Gymnasium Walls
** Based on Material Estimates
*** Current Structural System Schedule Duration = 395 days

Table 16 Summary of System Comparisons

Appendix A

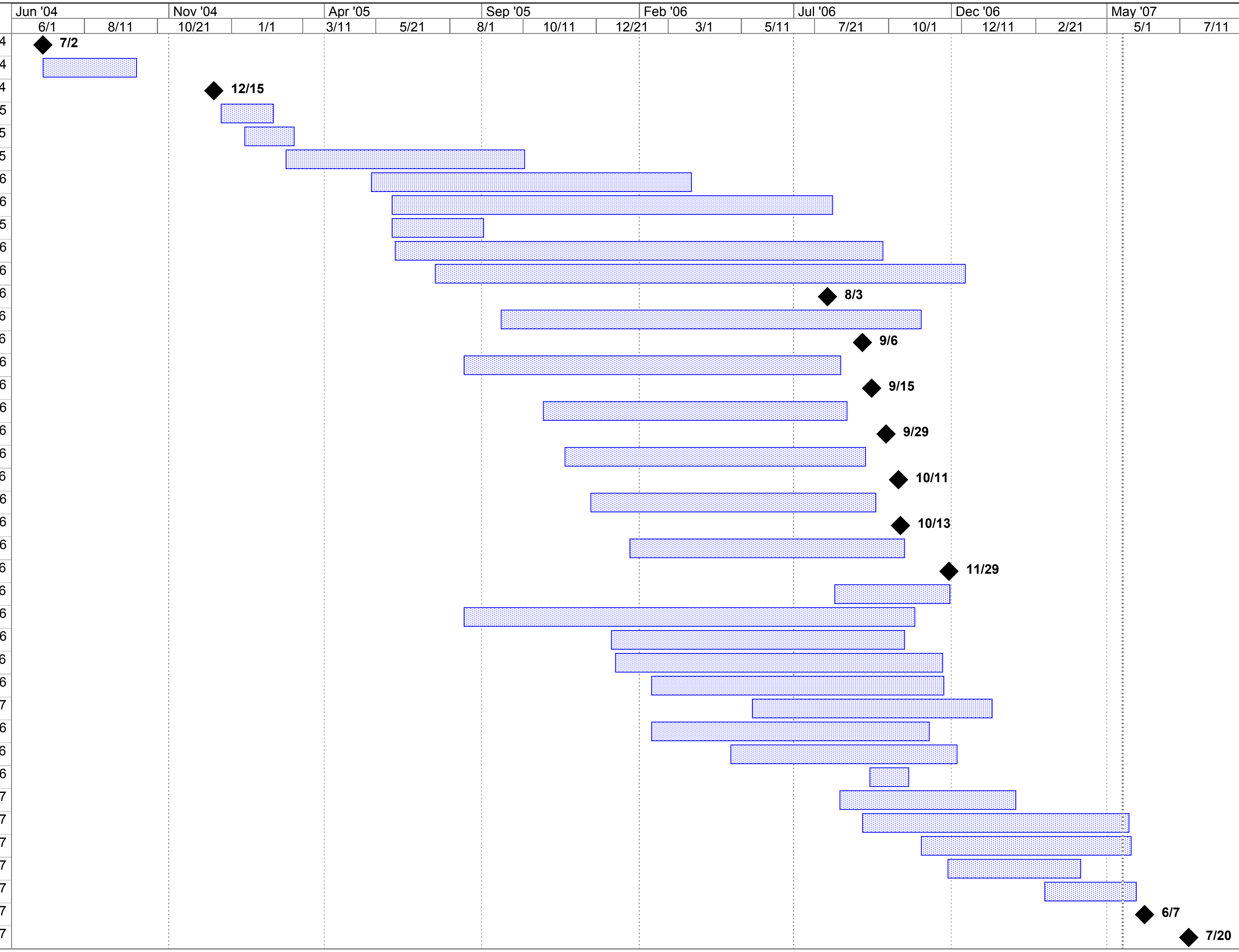
Phase A

Project Summary Schedule

T.C. Williams High School

Replacement Project

ID	Task Name	Duration	Start	Finish
1	Notice of Award	1 day?	Fri 7/2/04	Fri 7/2/04
2	Value Engineering / Management Period	65 days?	Fri 7/2/04	Thu 9/30/04
3	Mobilization	1 day?	Wed 12/15/04	Wed 12/15/04
4	Phase A1 Demo Career Tech.	37 days?	Wed 12/22/04	Thu 2/10/05
5	Procure Building Permits	34 days?	Fri 1/14/05	Wed 3/2/05
6	Submittal Review/Approval	166 days?	Wed 2/23/05	Wed 10/12/05
7	Underslab Utilities	223 days?	Tue 5/17/05	Thu 3/23/06
8	Excavate Foundations	306 days?	Mon 6/6/05	Mon 8/7/06
9	Geopiers Foundation	65 days?	Mon 6/6/05	Fri 9/2/05
10	Concrete Foundations	338 days?	Thu 6/9/05	Mon 9/25/06
11	CMU Walls	369 days?	Mon 7/18/05	Thu 12/14/06
12	Area 3 - NW Tower Dry-in	1 day?	Thu 8/3/06	Thu 8/3/06
13	Exterior Brick	292 days?	Tue 9/20/05	Wed 11/1/06
14	Area 5 - GYM Wing Dry-in	1 day?	Wed 9/6/06	Wed 9/6/06
15	SOG Concrete	262 days?	Mon 8/15/05	Tue 8/15/06
16	Area 7 - Auditorium Dry-in	1 day?	Fri 9/15/06	Fri 9/15/06
17	Structural Steel Erection	211 days?	Mon 10/31/05	Mon 8/21/06
18	Area 1 - NE Tower Dry-in	1 day?	Fri 9/29/06	Fri 9/29/06
19	Metal Deck Installation	210 days?	Mon 11/21/05	Fri 9/8/06
20	Area 6 - Mech/Elec Wedge / Auto Strip Dry-in	1 day?	Wed 10/11/06	Wed 10/11/06
21	SOD Elevated Concrete	197 days?	Fri 12/16/05	Mon 9/18/06
22	Area 4 - Kitchen Wedge Dry-in	1 day?	Fri 10/13/06	Fri 10/13/06
23	Roofing	191 days?	Mon 1/23/06	Mon 10/16/06
24	Area 2 - Center Court Dry-in	1 day?	Wed 11/29/06	Wed 11/29/06
25	Windows & Curtainwalls	80 days?	Thu 8/10/06	Wed 11/29/06
26	Electrical System Rough-in	314 days?	Mon 8/15/05	Thu 10/26/06
27	Plumbing Rough-in	203 days?	Thu 1/5/06	Mon 10/16/06
28	HVAC Duct & Piping Rough-in	228 days?	Mon 1/9/06	Wed 11/22/06
29	Fire Alarm Rough-in	204 days?	Mon 2/13/06	Thu 11/23/06
30	Fire Protection Rough-in	167 days?	Mon 5/22/06	Tue 1/9/07
31	Install AHU Equipment	194 days?	Mon 2/13/06	Thu 11/9/06
32	Install Electrical Panels & Transformers	158 days?	Mon 5/1/06	Wed 12/6/06
33	Fire Alarm Trim-out	28 days?	Wed 9/13/06	Fri 10/20/06
34	Plumbing Fixtures	123 days?	Tue 8/15/06	Thu 2/1/07
35	Electrical Systems Trim-out	185 days?	Wed 9/6/06	Tue 5/22/07
36	Hang Doors & Hardware	146 days?	Thu 11/2/06	Thu 5/24/07
37	Grilles & Diffusers	93 days?	Tue 11/28/06	Thu 4/5/07
38	Testing & Balancing	63 days?	Fri 3/2/07	Tue 5/29/07
39	Phase A2 Substancial Completion	1 day?	Thu 6/7/07	Thu 6/7/07
40	Phase A2 Final Completion	1 day?	Fri 7/20/07	Fri 7/20/07



Project: T.C. Williams High School
Summary Schedule
Date: April 12, 2007

Task		Progress		Summary		External Tasks		Deadline
Split		Milestone		Project Summary		External Milestone		

Appendix B

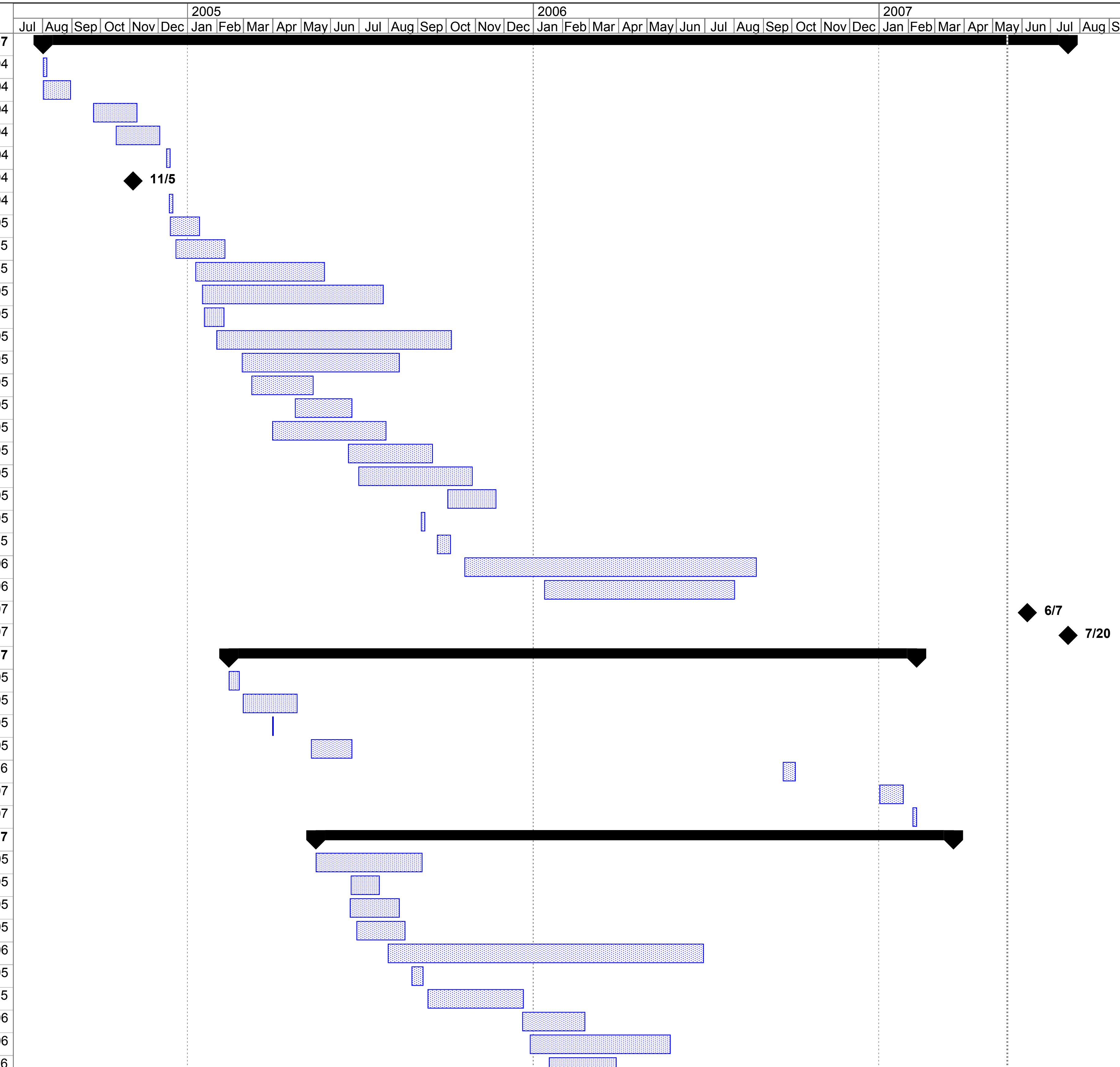
Phase A

Detailed Project Schedule

T.C. Williams High School

Replacement Project

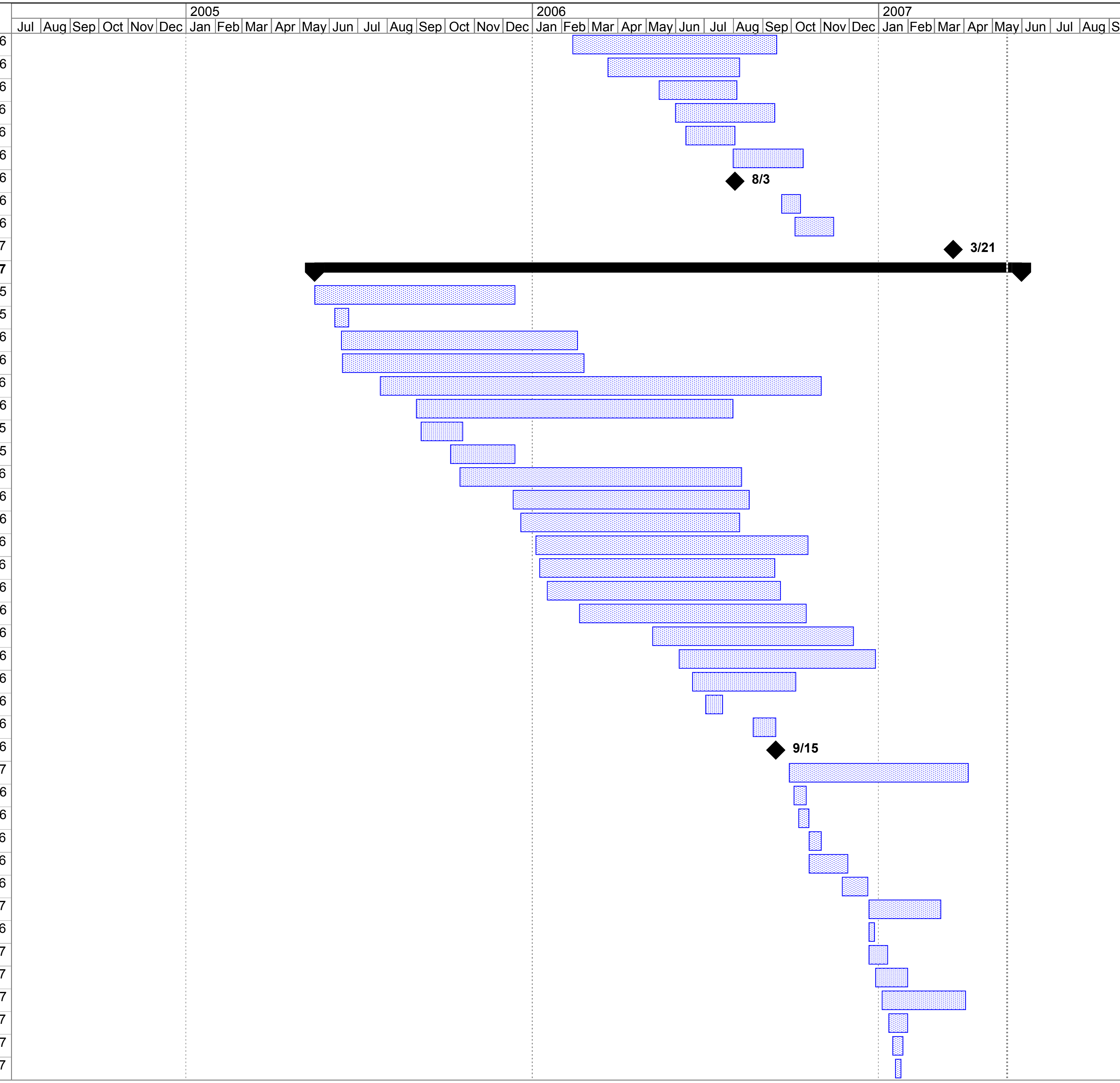
ID		Task Name	Duration	Start	Finish
1		**General Project**	**774 days?**	**Mon 8/2/04**	**Fri 7/20/07**
2		1st Mobilization (Interim Classwork)	4 days?	Mon 8/2/04	Thu 8/5/04
3		Interim Classroom Remodel @ Existing TCWHS	21 days?	Mon 8/2/04	Mon 8/30/04
4		Set-Up Temp. Classroom Trailers	32 days?	Fri 9/24/04	Mon 11/8/04
5		Install Temp. Utilities to Temp. Classrooms	34 days?	Mon 10/18/04	Thu 12/2/04
6		Temporary Power to Trailers	2 days?	Fri 12/10/04	Mon 12/13/04
7		Final Notice to Proceed	0 days	Fri 11/5/04	Fri 11/5/04
8		2nd Mobilization (Site)	4 days?	Mon 12/13/04	Thu 12/16/04
9		Install Construction Barrier Fence	23 days?	Tue 12/14/04	Thu 1/13/05
10		Demo. Classroom Trailers, Trees, Career Tech	38 days?	Mon 12/20/04	Wed 2/9/05
11		Sanitary Sewer	98 days?	Mon 1/10/05	Wed 5/25/05
12		Storm Sewer	137 days?	Mon 1/17/05	Tue 7/26/05
13		Relocate Fire Hydrant	15 days?	Wed 1/19/05	Tue 2/8/05
14		Install Temp Power Switchgear	178 days?	Tue 2/1/05	Thu 10/6/05
15		Mass Excavation	120 days?	Mon 2/28/05	Fri 8/12/05
16		Site Shoring Systems	47 days?	Thu 3/10/05	Fri 5/13/05
17		Shot Crete Retaining Wall	44 days?	Mon 4/25/05	Thu 6/23/05
18		Remove Existing U/G Utilities	86 days?	Fri 4/1/05	Fri 7/29/05
19		Ductbank	65 days?	Mon 6/20/05	Fri 9/16/05
20		Water Line	86 days?	Fri 7/1/05	Fri 10/28/05
21		Gas Service Line	37 days?	Mon 10/3/05	Tue 11/22/05
22		Install VA Power Xmfr for Temp	4 days?	Mon 9/5/05	Thu 9/8/05
23		Install Temp Power Switchgear	10 days?	Thu 9/22/05	Wed 10/5/05
24		Install Site Lighting	220 days?	Fri 10/21/05	Thu 8/24/06
25		VA Power Transformer	143 days?	Fri 1/13/06	Tue 8/1/06
26		Substantial Completion	0 days	Thu 6/7/07	Thu 6/7/07
27		Final Completion	0 days	Fri 7/20/07	Fri 7/20/07
28		**Cistern**	**520 days?**	**Mon 2/14/05**	**Fri 2/9/07**
29		Excavate Cistern	9 days?	Mon 2/14/05	Thu 2/24/05
30		FRP Cistern	41 days?	Tue 3/1/05	Tue 4/26/05
31		Install Cistern Pipe MH	1 day	Fri 4/1/05	Fri 4/1/05
32		Backfill Cistern	31 days?	Thu 5/12/05	Thu 6/23/05
33		Install Cistern Pumps	9 days?	Fri 9/22/06	Wed 10/4/06
34		Roof Drains tied to Cistern	19 days?	Tue 1/2/07	Fri 1/26/07
35		Startup Cistern pumps	4 days?	Tue 2/6/07	Fri 2/9/07
36		**Area 3 - NW Tower**	**481 days?**	**Tue 5/17/05**	**Wed 3/21/07**
37		Underslab Plumbing	80 days?	Tue 5/17/05	Mon 9/5/05
38		Geopier Foundations	22 days?	Thu 6/23/05	Fri 7/22/05
39		Excavate Foundations	38 days?	Wed 6/22/05	Fri 8/12/05
40		Concrete Foundations	37 days?	Wed 6/29/05	Thu 8/18/05
41		Block Masonry	239 days?	Mon 8/1/05	Thu 6/29/06
42		Underslab Electrical	8 days?	Fri 8/26/05	Tue 9/6/05
43		SOG Concrete	73 days?	Mon 9/12/05	Wed 12/21/05
44		Structural Steel Erection	48 days?	Wed 12/21/05	Fri 2/24/06
45		Metal Decking	106 days?	Thu 12/29/05	Thu 5/25/06
46		SOD Elevated Concrete	51 days?	Wed 1/18/06	Wed 3/29/06



Project: T.C. Williams High School
Detailed Project Schedule
Date: April 12, 2007

Task		Progress		Summary		External Tasks		Deadline	
Split		Milestone		Project Summary		External Milestone			

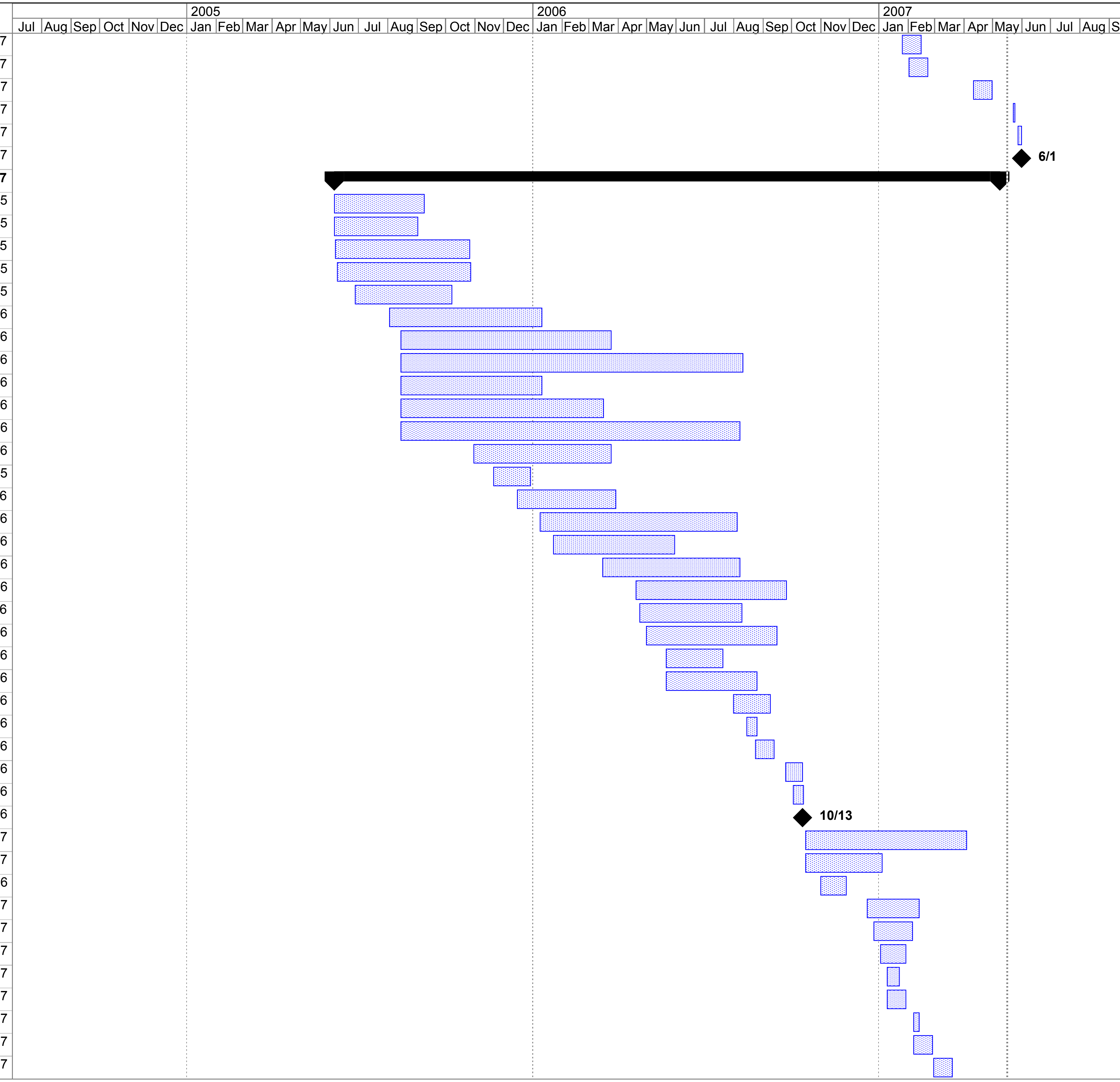
ID	Task Name	Duration	Start	Finish
47	Fire Alarm Rough-in	155 days?	Mon 2/13/06	Fri 9/15/06
48	Brick Masonry	99 days?	Wed 3/22/06	Mon 8/7/06
49	Install Transformers & Panel Boards	60 days?	Mon 5/15/06	Fri 8/4/06
50	Install Air Handling Equipment	75 days?	Thu 6/1/06	Wed 9/13/06
51	Roofing	38 days?	Mon 6/12/06	Wed 8/2/06
52	Install Security Equip.	54 days?	Tue 8/1/06	Fri 10/13/06
53	NW Tower Dry-In	0 days?	Thu 8/3/06	Thu 8/3/06
54	Install Consolidation Boxes	14 days?	Thu 9/21/06	Tue 10/10/06
55	Install AV & Communication Equip.	29 days?	Thu 10/5/06	Tue 11/14/06
56	NW Tower Complete	0 days?	Wed 3/21/07	Wed 3/21/07
57	**Area 7 - Auditorium**	**533 days?**	**Tue 5/17/05**	**Fri 6/1/07**
58	Underslab Plumbing	151 days?	Tue 5/17/05	Tue 12/13/05
59	Geopier Foundations	11 days?	Tue 6/7/05	Tue 6/21/05
60	Excavate Foundations	179 days?	Tue 6/14/05	Fri 2/17/06
61	Concrete Foundations	183 days?	Wed 6/15/05	Fri 2/24/06
62	Block Masonry	333 days?	Mon 7/25/05	Wed 11/1/06
63	SOG Concrete	238 days?	Thu 9/1/05	Mon 7/31/06
64	FRP Auditorium Seating	32 days?	Tue 9/6/05	Wed 10/19/05
65	Underslab Electrical	48 days?	Fri 10/7/05	Tue 12/13/05
66	Brick Masonry	213 days?	Mon 10/17/05	Wed 8/9/06
67	Structural Steel Erection	179 days?	Mon 12/12/05	Thu 8/17/06
68	Metal Decking	165 days?	Tue 12/20/05	Mon 8/7/06
69	Plumbing Rough-In	205 days?	Thu 1/5/06	Wed 10/18/06
70	Roofing	178 days?	Mon 1/9/06	Wed 9/13/06
71	Electrical Systems Rough-In	176 days?	Tue 1/17/06	Tue 9/19/06
72	HVAC Rough-In	171 days?	Mon 2/20/06	Mon 10/16/06
73	Install Transformers & Panel Boards	152 days?	Mon 5/8/06	Tue 12/5/06
74	Install AV & Communication Equip.	149 days?	Mon 6/5/06	Thu 12/28/06
75	Fire Alarm Rough-in	79 days?	Mon 6/19/06	Thu 10/5/06
76	Fire Protection Rough-In	14 days?	Mon 7/3/06	Thu 7/20/06
77	Windows & Curtainwalls	18 days?	Tue 8/22/06	Thu 9/14/06
78	Auditorium Dry-In	0 days	Fri 9/15/06	Fri 9/15/06
79	Install Lighting Components	135 days?	Fri 9/29/06	Thu 4/5/07
80	Install Security Equip.	9 days?	Wed 10/4/06	Mon 10/16/06
81	Trim-out Fire Alarm	9 days?	Mon 10/9/06	Thu 10/19/06
82	Install Plumbing Fixtures	9 days?	Fri 10/20/06	Wed 11/1/06
83	Install Air Handling Equipment	29 days?	Fri 10/20/06	Wed 11/29/06
84	Drywall Partitions	19 days?	Fri 11/24/06	Wed 12/20/06
85	Prime & Paint	54 days?	Fri 12/22/06	Wed 3/7/07
86	Arch. Pre-Cast	4 days?	Fri 12/22/06	Wed 12/27/06
87	Install Consolidation Boxes	14 days?	Fri 12/22/06	Wed 1/10/07
88	Install ACT Grid & Drop Tile	24 days?	Fri 12/29/06	Wed 1/31/07
89	Floor Finishes	62 days?	Fri 1/5/07	Mon 4/2/07
90	Install Grilles & Diffusers	14 days?	Fri 1/12/07	Wed 1/31/07
91	Trim-out Power	9 days?	Tue 1/16/07	Fri 1/26/07
92	Install Lockers	4 days?	Fri 1/19/07	Wed 1/24/07



Project: T.C. Williams High School
Detailed Project Schedule
Date: April 12, 2007

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

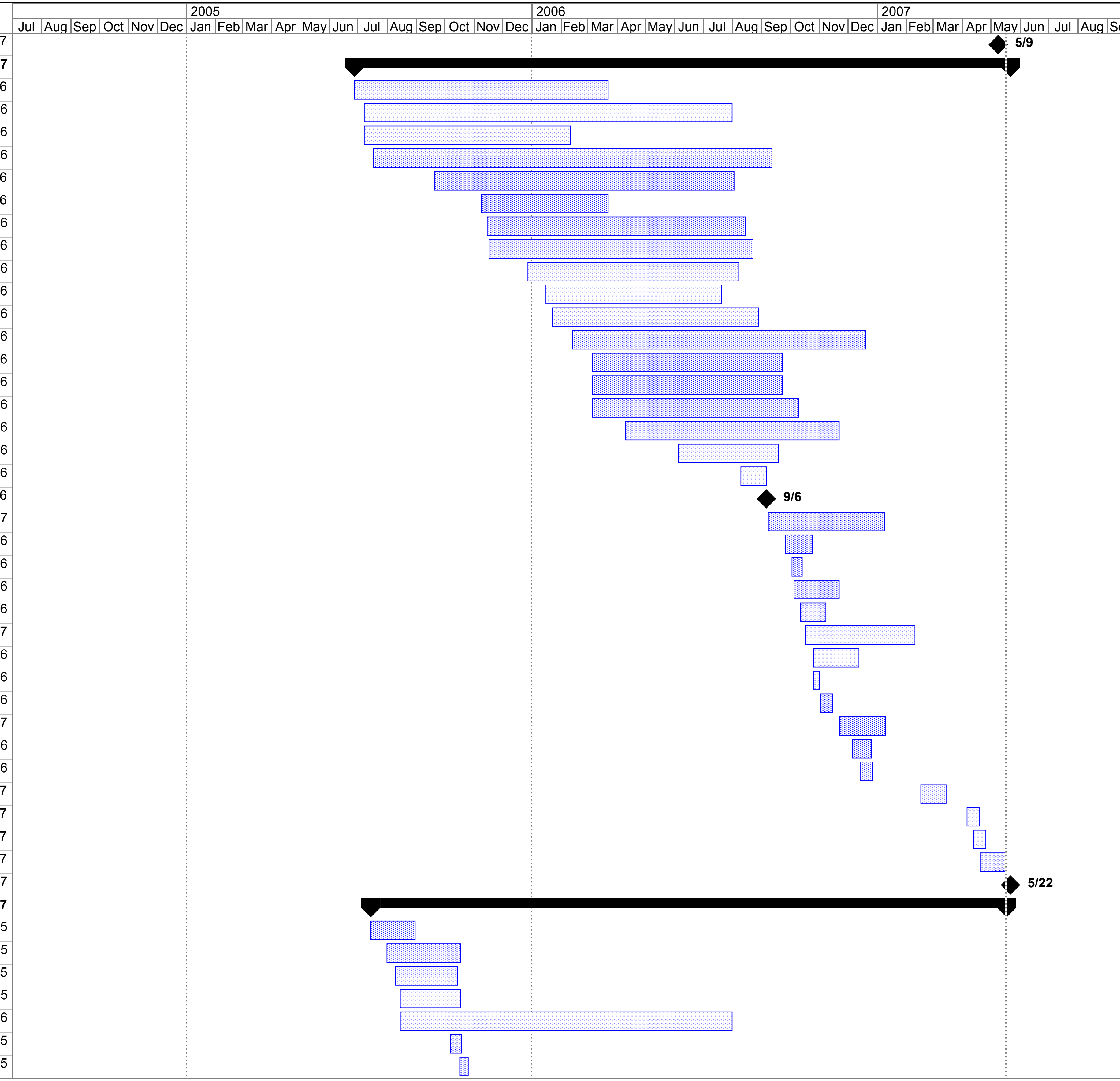
ID		Task Name	Duration	Start	Finish
93		Hang Doors & Hardware	14 days?	Fri 1/26/07	Wed 2/14/07
94		Install Millwork Components	14 days?	Fri 2/2/07	Wed 2/21/07
95		Install Stage Equip.	14 days?	Wed 4/11/07	Mon 4/30/07
96		Install Carpet	2 days?	Wed 5/23/07	Thu 5/24/07
97		Install Folding Partitions	4 days?	Mon 5/28/07	Thu 5/31/07
98		Auditorium Area Complete	0 days	Fri 6/1/07	Fri 6/1/07
99		**Area 4 - Kitchen Wedge**	**502 days?**	**Mon 6/6/05**	**Wed 5/9/07**
100		Install Elevator Shafts & FRP Pit	69 days?	Mon 6/6/05	Thu 9/8/05
101		Geopier Foundations	64 days?	Mon 6/6/05	Thu 9/1/05
102		Excavate Foundations	102 days?	Tue 6/7/05	Wed 10/26/05
103		Concrete Foundations	101 days?	Thu 6/9/05	Thu 10/27/05
104		FRP Concrete Columns	74 days?	Tue 6/28/05	Fri 10/7/05
105		Underslab Plumbing	115 days?	Wed 8/3/05	Tue 1/10/06
106		Radius Beam	160 days?	Mon 8/15/05	Fri 3/24/06
107		Block Masonry	259 days?	Mon 8/15/05	Thu 8/10/06
108		Underslab Electrical	107 days?	Mon 8/15/05	Tue 1/10/06
109		SOG Concrete	154 days?	Mon 8/15/05	Thu 3/16/06
110		Electrical Systems Rough-In	256 days?	Mon 8/15/05	Mon 8/7/06
111		Structural Steel Erection	105 days?	Mon 10/31/05	Fri 3/24/06
112		Metal Decking	29 days?	Mon 11/21/05	Thu 12/29/05
113		SOD Elevated Concrete	74 days?	Fri 12/16/05	Wed 3/29/06
114		HVAC Rough-In	150 days?	Mon 1/9/06	Fri 8/4/06
115		Plumbing Rough-In	92 days?	Mon 1/23/06	Tue 5/30/06
116		Brick Masonry	103 days?	Thu 3/16/06	Mon 8/7/06
117		Install Air Handling Equipment	113 days?	Thu 4/20/06	Mon 9/25/06
118		Roofing	78 days?	Mon 4/24/06	Wed 8/9/06
119		Install Transformers & Panel Boards	100 days?	Mon 5/1/06	Fri 9/15/06
120		Fire Protection Rough-In	44 days?	Mon 5/22/06	Thu 7/20/06
121		Fire Alarm Rough-in	70 days?	Mon 5/22/06	Fri 8/25/06
122		Install AV & Communication Equip.	29 days?	Tue 8/1/06	Fri 9/8/06
123		Install Plumbing Fixtures	9 days?	Tue 8/15/06	Fri 8/25/06
124		Install Consolidation Boxes	14 days?	Thu 8/24/06	Tue 9/12/06
125		Windows & Curtainwalls	14 days?	Mon 9/25/06	Thu 10/12/06
126		Install Security Equip.	9 days?	Tue 10/3/06	Fri 10/13/06
127		Kitchen Dry-In	0 days	Fri 10/13/06	Fri 10/13/06
128		Install Specialty Equipment	122 days?	Mon 10/16/06	Tue 4/3/07
129		Install Elevator Cabs	59 days?	Mon 10/16/06	Thu 1/4/07
130		Drywall Partitions	19 days?	Wed 11/1/06	Mon 11/27/06
131		Prime & Paint	39 days?	Wed 12/20/06	Mon 2/12/07
132		Install ACT Grid & Drop Tile	29 days?	Wed 12/27/06	Mon 2/5/07
133		Floor Finishes	19 days?	Wed 1/3/07	Mon 1/29/07
134		Install Grilles & Diffusers	9 days?	Wed 1/10/07	Mon 1/22/07
135		Install Lighting Components	14 days?	Wed 1/10/07	Mon 1/29/07
136		Install Lockers	4 days?	Wed 2/7/07	Mon 2/12/07
137		Install Millwork Components	14 days?	Wed 2/7/07	Mon 2/26/07
138		Hang Doors & Hardware	14 days?	Wed 2/28/07	Mon 3/19/07



Project: T.C. Williams High School
Detailed Project Schedule
Date: April 12, 2007

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

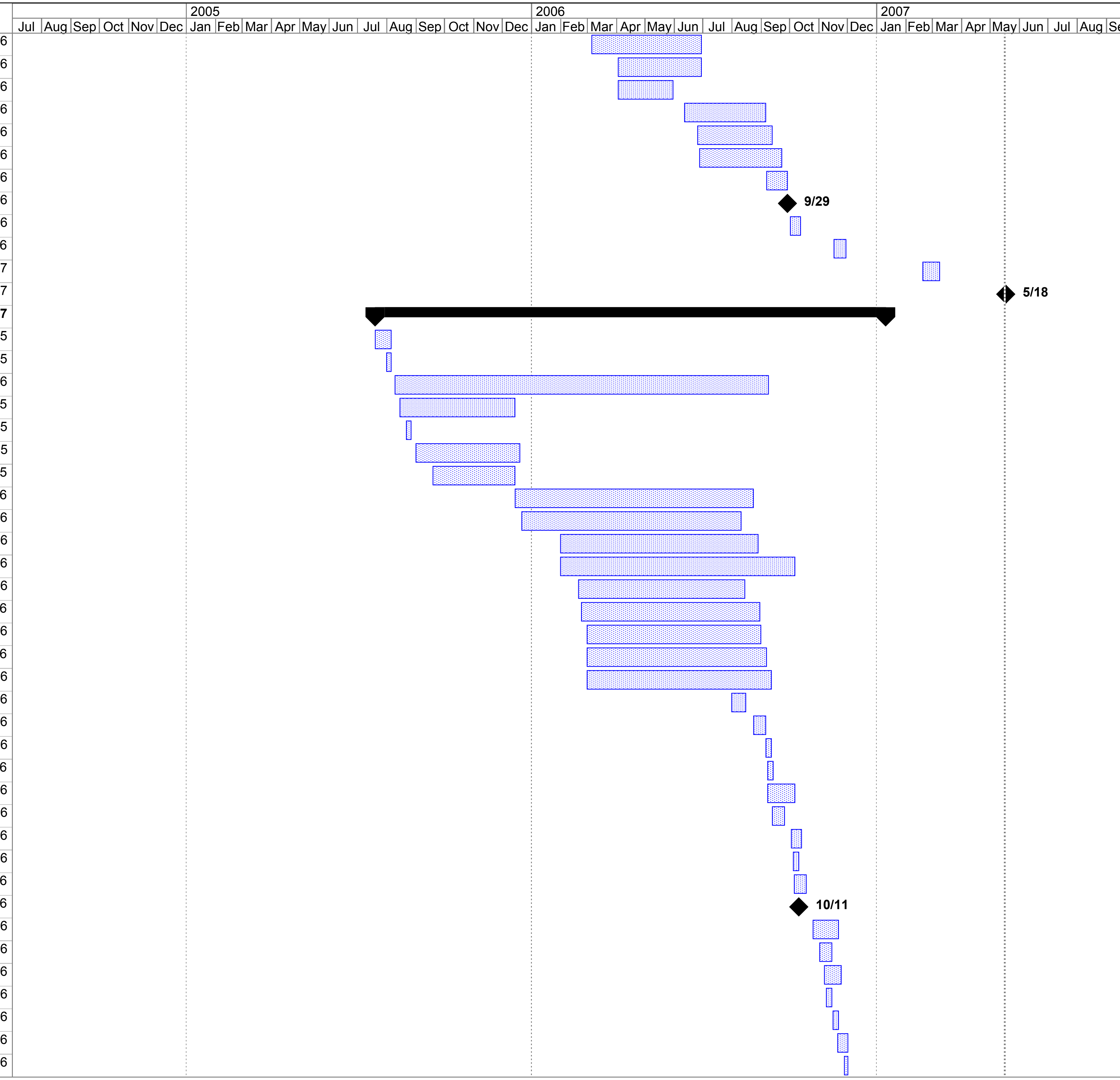
ID		Task Name	Duration	Start	Finish
139		Kitchen Complete	0 days	Wed 5/9/07	Wed 5/9/07
140		**Area 5 - Gymnasium**	**495 days?**	**Tue 6/28/05**	**Tue 5/22/07**
141		Underslab Plumbing	192 days?	Tue 6/28/05	Wed 3/22/06
142		Excavate Foundations	277 days?	Fri 7/8/05	Mon 7/31/06
143		Concrete Foundations	156 days?	Fri 7/8/05	Fri 2/10/06
144		Block Masonry	301 days?	Mon 7/18/05	Mon 9/11/06
145		Brick Masonry	227 days?	Tue 9/20/05	Wed 8/2/06
146		Underslab Electrical	96 days?	Wed 11/9/05	Wed 3/22/06
147		SOG Concrete	195 days?	Tue 11/15/05	Mon 8/14/06
148		Arch. Pre-Cast	199 days?	Thu 11/17/05	Tue 8/22/06
149		Structural Steel Erection	159 days?	Wed 12/28/05	Mon 8/7/06
150		Metal Decking	134 days?	Mon 1/16/06	Thu 7/20/06
151		Roofing	156 days?	Mon 1/23/06	Mon 8/28/06
152		Install Air Handling Equipment	222 days?	Mon 2/13/06	Tue 12/19/06
153		Electrical Systems Rough-In	145 days?	Mon 3/6/06	Fri 9/22/06
154		Plumbing Rough-In	145 days?	Mon 3/6/06	Fri 9/22/06
155		Fire Alarm Rough-in	156 days?	Mon 3/6/06	Mon 10/9/06
156		HVAC Rough-In	162 days?	Mon 4/10/06	Tue 11/21/06
157		Install Transformers & Panel Boards	76 days?	Mon 6/5/06	Mon 9/18/06
158		Windows & Curtainwalls	19 days?	Thu 8/10/06	Tue 9/5/06
159		GYM Dry-In	0 days	Wed 9/6/06	Wed 9/6/06
160		Fire Protection Rough-In	87 days?	Fri 9/8/06	Mon 1/8/07
161		Install Plumbing Fixtures	21 days?	Tue 9/26/06	Tue 10/24/06
162		Install Security Equip.	9 days?	Tue 10/3/06	Fri 10/13/06
163		Install GYM Ceiling Equip.	34 days?	Thu 10/5/06	Tue 11/21/06
164		Install Millwork Components	19 days?	Thu 10/12/06	Tue 11/7/06
165		Prime & Paint	84 days?	Tue 10/17/06	Fri 2/9/07
166		Install Lockers	34 days?	Thu 10/26/06	Tue 12/12/06
167		Install GYM Divider Curtain Track	4 days?	Thu 10/26/06	Tue 10/31/06
168		Hang Doors & Hardware	9 days?	Thu 11/2/06	Tue 11/14/06
169		GYM Ceiling Light Fixtures	35 days?	Wed 11/22/06	Tue 1/9/07
170		Install Consolidation Boxes	14 days?	Wed 12/6/06	Mon 12/25/06
171		Hang Doors & Hardware	9 days?	Thu 12/14/06	Tue 12/26/06
172		Install GYM Sub-Floor & Hardwood	19 days?	Fri 2/16/07	Wed 3/14/07
173		Floor Finishes	9 days?	Fri 4/6/07	Wed 4/18/07
174		Install Divider Curtains	9 days?	Fri 4/13/07	Wed 4/25/07
175		Install GYM Bleachers	19 days?	Fri 4/20/07	Wed 5/16/07
176		GYM Area Complete	0 days	Tue 5/22/07	Tue 5/22/07
177		**Area 1 - NE Tower**	**480 days?**	**Fri 7/15/05**	**Fri 5/18/07**
178		Geopier Foundations	33 days?	Fri 7/15/05	Tue 8/30/05
179		Underslab Plumbing	56 days?	Mon 8/1/05	Mon 10/17/05
180		Excavate Foundations	48 days?	Wed 8/10/05	Fri 10/14/05
181		Concrete Foundations	46 days?	Mon 8/15/05	Mon 10/17/05
182		Block Masonry	251 days?	Mon 8/15/05	Mon 7/31/06
183		Underslab Electrical	8 days?	Fri 10/7/05	Tue 10/18/05
184		SOG Concrete	7 days?	Mon 10/17/05	Tue 10/25/05



Project: T.C. Williams High School
Detailed Project Schedule
Date: April 12, 2007

Task		Progress		Summary		External Tasks		Deadline	
Split		Milestone		Project Summary		External Milestone			

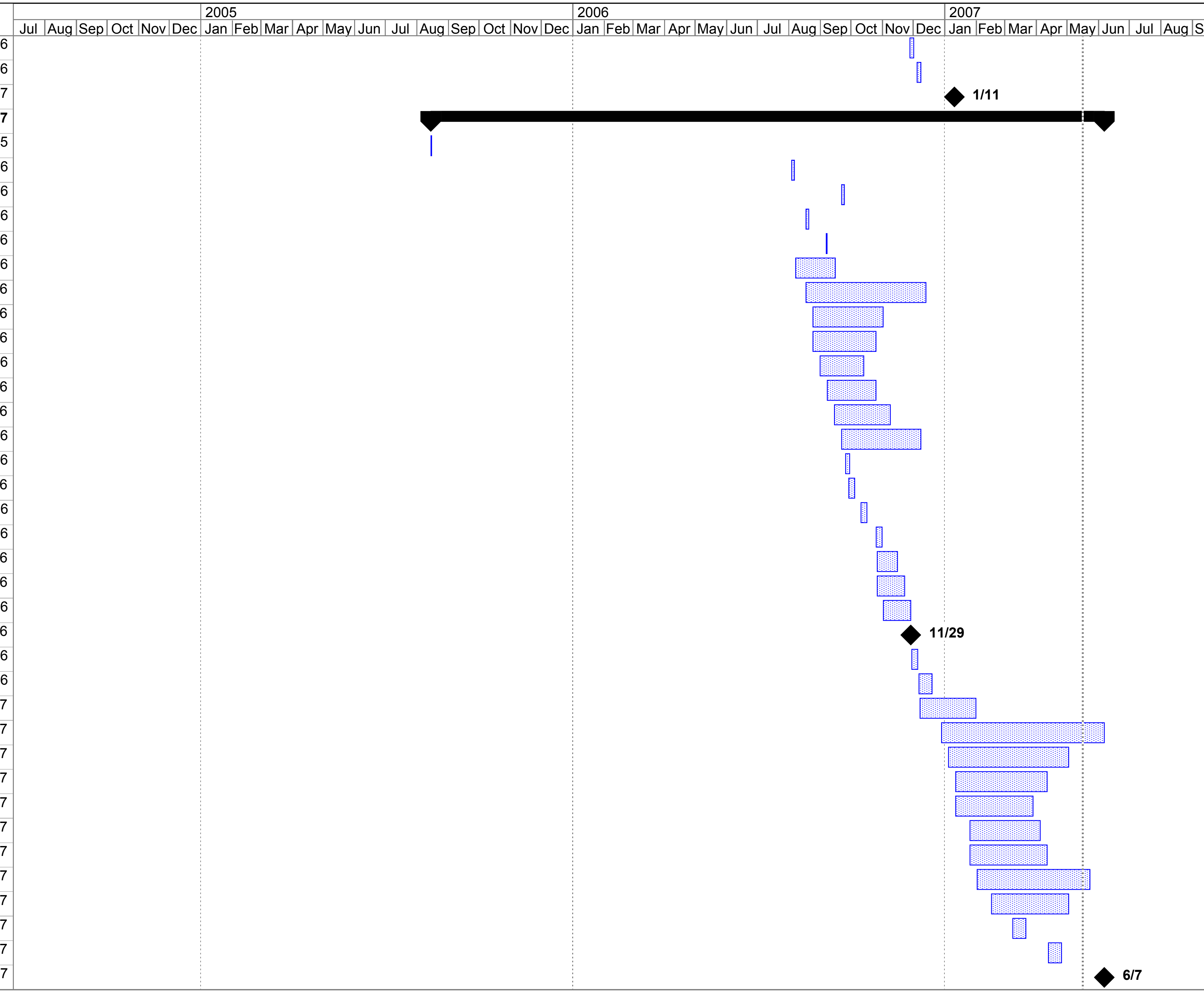
ID		Task Name	Duration	Start	Finish
185		Structural Steel Erection	84 days?	Mon 3/6/06	Thu 6/29/06
186		Metal Decking	64 days?	Mon 4/3/06	Thu 6/29/06
187		SOD Elevated Concrete	42 days?	Mon 4/3/06	Tue 5/30/06
188		Brick Masonry	62 days?	Mon 6/12/06	Tue 9/5/06
189		Fire Alarm Rough-in	57 days?	Mon 6/26/06	Tue 9/12/06
190		Install Air Handling Equipment	63 days?	Wed 6/28/06	Fri 9/22/06
191		Roofing	16 days?	Thu 9/7/06	Thu 9/28/06
192		NE Tower Dry-In	0 days	Fri 9/29/06	Fri 9/29/06
193		Install Transformers & Panel Boards	9 days?	Mon 10/2/06	Thu 10/12/06
194		Install Security Equip.	9 days?	Fri 11/17/06	Wed 11/29/06
195		Install Consolidation Boxes	14 days?	Mon 2/19/07	Thu 3/8/07
196		NE Tower Complete	0 days	Fri 5/18/07	Fri 5/18/07
197		**Area 6 - Mech/Elect Wedge - Auto Strip**	**386 days?**	**Wed 7/20/05**	**Thu 1/11/07**
198		Excavate Foundations	13 days?	Wed 7/20/05	Fri 8/5/05
199		Concrete Foundations	5 days?	Mon 8/1/05	Fri 8/5/05
200		Block Masonry	283 days?	Wed 8/10/05	Fri 9/8/06
201		Underslab Electrical	88 days?	Mon 8/15/05	Wed 12/14/05
202		Concrete Foundations	5 days?	Mon 8/22/05	Fri 8/26/05
203		SOG Concrete	78 days?	Thu 9/1/05	Mon 12/19/05
204		Underslab Plumbing	63 days?	Mon 9/19/05	Wed 12/14/05
205		Electrical Systems Rough-In	180 days?	Thu 12/15/05	Wed 8/23/06
206		Structural Steel Erection	166 days?	Thu 12/22/05	Thu 8/10/06
207		Install Transformers & Panel Boards	149 days?	Wed 2/1/06	Mon 8/28/06
208		Install Main Switchgear	178 days?	Wed 2/1/06	Fri 10/6/06
209		Metal Decking	126 days?	Mon 2/20/06	Mon 8/14/06
210		Roofing	135 days?	Thu 2/23/06	Wed 8/30/06
211		HVAC Rough-In	132 days?	Wed 3/1/06	Thu 8/31/06
212		Plumbing Rough-In	136 days?	Wed 3/1/06	Wed 9/6/06
213		Fire Alarm Rough-in	139 days?	Wed 3/1/06	Mon 9/11/06
214		Brick Masonry	11 days?	Tue 8/1/06	Tue 8/15/06
215		Fire Protection Rough-In	9 days?	Thu 8/24/06	Tue 9/5/06
216		Trim-out Power	4 days?	Wed 9/6/06	Mon 9/11/06
217		Install Plumbing Fixtures	4 days?	Fri 9/8/06	Wed 9/13/06
218		Install Air Handling Equipment	21 days?	Fri 9/8/06	Fri 10/6/06
219		Trim-out Fire Alarm	9 days?	Wed 9/13/06	Mon 9/25/06
220		Install Security Equip.	9 days?	Tue 10/3/06	Fri 10/13/06
221		Windows & Curtainwalls	4 days?	Thu 10/5/06	Tue 10/10/06
222		Trim-out Communication	9 days?	Fri 10/6/06	Wed 10/18/06
223		Mech. / Elect. Wedge Dry-In	0 days	Wed 10/11/06	Wed 10/11/06
224		Prime & Paint	19 days?	Thu 10/26/06	Tue 11/21/06
225		Floor Finishes	9 days?	Thu 11/2/06	Tue 11/14/06
226		Install Consolidation Boxes	14 days?	Tue 11/7/06	Fri 11/24/06
227		Install Lockers	4 days?	Thu 11/9/06	Tue 11/14/06
228		Hang Doors & Hardware	4 days?	Thu 11/16/06	Tue 11/21/06
229		Install ACT Grid & Drop Tile	9 days?	Tue 11/21/06	Fri 12/1/06
230		Install Grilles & Diffusers	4 days?	Tue 11/28/06	Fri 12/1/06



Project: T.C. Williams High School
Detailed Project Schedule
Date: April 12, 2007

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

ID		Task Name	Duration	Start	Finish
231		Install Lighting Components	4 days?	Tue 11/28/06	Fri 12/1/06
232		Install Millwork Components	4 days?	Tue 12/5/06	Fri 12/8/06
233		Mech. / Elect. Wedge Complete	0 days	Thu 1/11/07	Thu 1/11/07
234		**Area 2 - Center Court**	**473 days?**	**Mon 8/15/05**	**Thu 6/7/07**
235		Geopier Foundations	1 day?	Mon 8/15/05	Tue 8/16/05
236		Excavate Foundations	1 day?	Fri 8/4/06	Mon 8/7/06
237		Concrete Foundations	1 day?	Fri 9/22/06	Mon 9/25/06
238		Structural Steel Erection	1 day?	Fri 8/18/06	Mon 8/21/06
239		Metal Decking	1 day?	Thu 9/7/06	Fri 9/8/06
240		SOD Elevated Concrete	29 days?	Tue 8/8/06	Fri 9/15/06
241		Block Masonry	84 days?	Fri 8/18/06	Wed 12/13/06
242		HVAC Rough-In	49 days?	Fri 8/25/06	Wed 11/1/06
243		Electrical Systems Rough-In	44 days?	Fri 8/25/06	Wed 10/25/06
244		Plumbing Rough-In	31 days?	Fri 9/1/06	Fri 10/13/06
245		Fire Protection Rough-In	34 days?	Fri 9/8/06	Wed 10/25/06
246		Install Air Handling Equipment	39 days?	Fri 9/15/06	Wed 11/8/06
247		Roofing	56 days?	Fri 9/22/06	Fri 12/8/06
248		Underslab Plumbing	4 days?	Tue 9/26/06	Fri 9/29/06
249		Underslab Electrical	4 days?	Fri 9/29/06	Wed 10/4/06
250		SOG Concrete	4 days?	Wed 10/11/06	Mon 10/16/06
251		Brick Masonry	4 days?	Thu 10/26/06	Tue 10/31/06
252		Install Consolidation Boxes	14 days?	Fri 10/27/06	Wed 11/15/06
253		Fire Alarm Rough-in	19 days?	Fri 10/27/06	Wed 11/22/06
254		Windows & Curtainwalls	19 days?	Thu 11/2/06	Tue 11/28/06
255		Center Court Dry-In	0 days	Wed 11/29/06	Wed 11/29/06
256		Install Transformers & Panel Boards	4 days?	Thu 11/30/06	Tue 12/5/06
257		Install Security Equip.	9 days?	Thu 12/7/06	Tue 12/19/06
258		Install Plumbing Fixtures	39 days?	Fri 12/8/06	Wed 1/31/07
259		Prime & Paint	114 days?	Fri 12/29/06	Wed 6/6/07
260		Trim-out Communication	84 days?	Fri 1/5/07	Wed 5/2/07
261		Install ACT Grid & Drop Tile	64 days?	Fri 1/12/07	Wed 4/11/07
262		Floor Finishes	54 days?	Fri 1/12/07	Wed 3/28/07
263		Install Grilles & Diffusers	49 days?	Fri 1/26/07	Wed 4/4/07
264		Install Lighting Components	54 days?	Fri 1/26/07	Wed 4/11/07
265		Hang Doors & Hardware	79 days?	Fri 2/2/07	Wed 5/23/07
266		Install Millwork Components	54 days?	Fri 2/16/07	Wed 5/2/07
267		Trim-out Power	9 days?	Fri 3/9/07	Wed 3/21/07
268		Trim-out Security	9 days?	Fri 4/13/07	Wed 4/25/07
269		Center Court Complete	0 days	Thu 6/7/07	Thu 6/7/07



Project: T.C. Williams High School
Detailed Project Schedule
Date: April 12, 2007

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

Appendix C

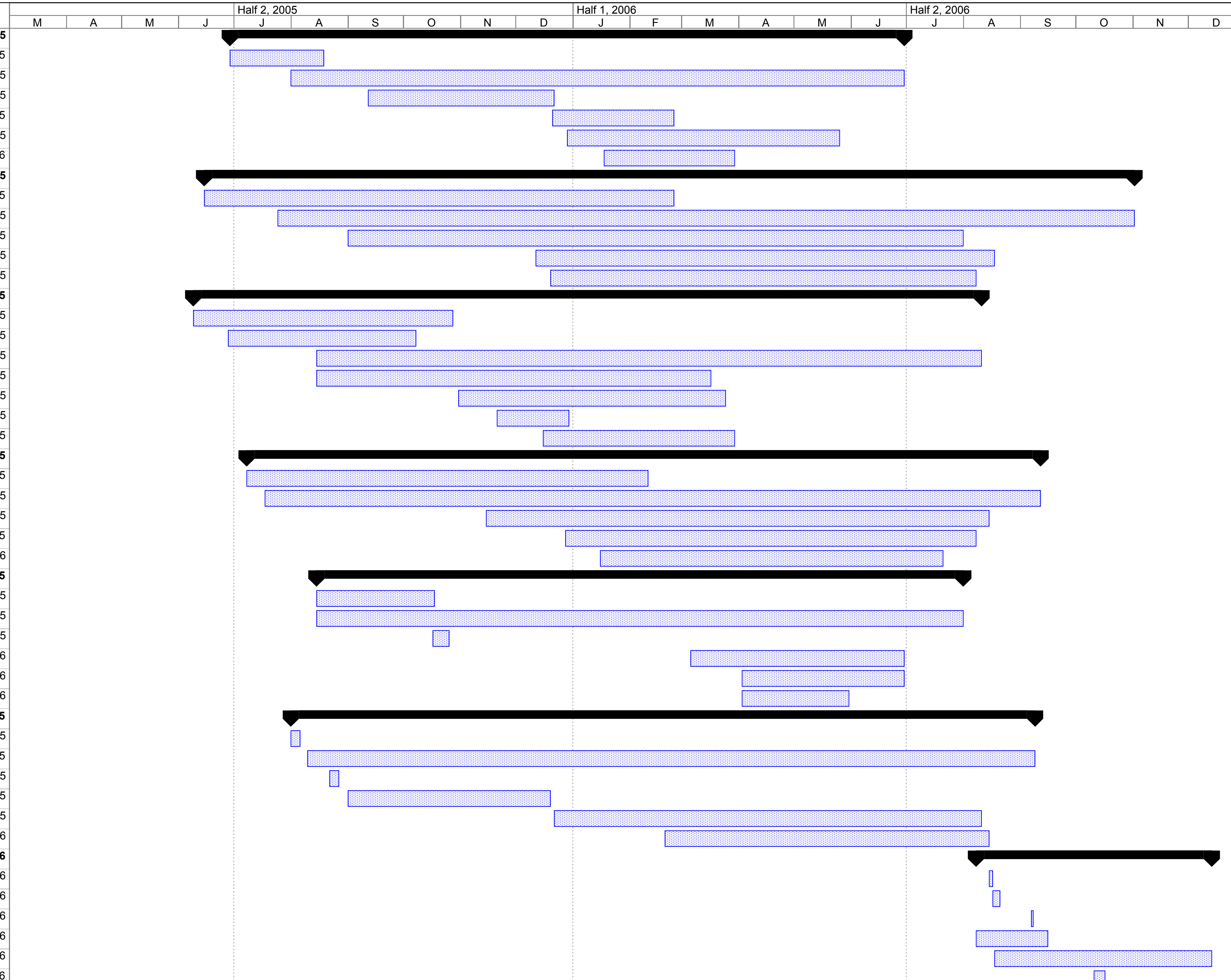
Phase A

Structural Schedule

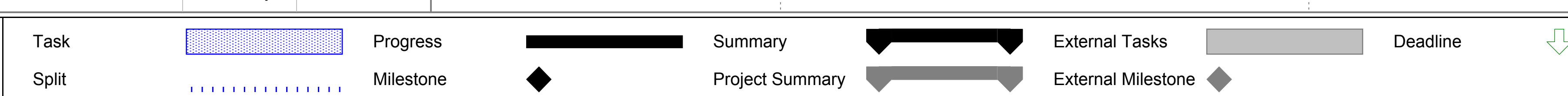
T.C. Williams High School

Replacement Project

ID	Task Name	Duration	Start
1	**Area 3 - NW Tower**	**262 days?**	**Wed 6/29/05**
2	(3) Concrete Foundations	37 days?	Wed 6/29/05
3	(3) Block Masonry	239 days?	Mon 8/1/05
4	(3) SOG Concrete	73 days?	Mon 9/12/05
5	(3) Structural Steel Erection	48 days?	Wed 12/21/05
6	(3) Metal Decking	106 days?	Thu 12/29/05
7	(3) SOD Elevated Concrete	51 days?	Wed 1/18/06
8	**Area 7 - Auditorium**	**361 days?**	**Wed 6/15/05**
9	(7) Concrete Foundations	183 days?	Wed 6/15/05
10	(7) Block Masonry	333 days?	Mon 7/25/05
11	(7) SOG Concrete	238 days?	Thu 9/1/05
12	(7) Structural Steel Erection	179 days?	Mon 12/12/05
13	(7) Metal Decking	165 days?	Tue 12/20/05
14	**Area 4 - Kitchen Wedge**	**306 days?**	**Thu 6/9/05**
15	(4) Concrete Foundations	101 days?	Thu 6/9/05
16	(4) FRP Concrete Columns	74 days?	Tue 6/28/05
17	(4) Block Masonry	259 days?	Mon 8/15/05
18	(4) SOG Concrete	154 days?	Mon 8/15/05
19	(4) Structural Steel Erection	105 days?	Mon 10/31/05
20	(4) Metal Decking	29 days?	Mon 11/21/05
21	(4) SOD Elevated Concrete	74 days?	Fri 12/16/05
22	**Area 5 - Gymnasium**	**307 days?**	**Fri 7/8/05**
23	(5) Concrete Foundations	156 days?	Fri 7/8/05
24	(5) Block Masonry	301 days?	Mon 7/18/05
25	(5) SOG Concrete	195 days?	Tue 11/15/05
26	(5) Structural Steel Erection	159 days?	Wed 12/28/05
27	(5) Metal Decking	134 days?	Mon 1/16/06
28	**Area 1 - NE Tower**	**251 days?**	**Mon 8/15/05**
29	(1) Concrete Foundations	46 days?	Mon 8/15/05
30	(1) Block Masonry	251 days?	Mon 8/15/05
31	(1) SOG Concrete	7 days?	Mon 10/17/05
32	(1) Structural Steel Erection	84 days?	Mon 3/6/06
33	(1) Metal Decking	64 days?	Mon 4/3/06
34	(1) SOD Elevated Concrete	42 days?	Mon 4/3/06
35	**Area 6 - Mech/Elect Wedge - Auto Strip**	**290 days?**	**Mon 8/1/05**
36	(6) Concrete Foundations	5 days?	Mon 8/1/05
37	(6) Block Masonry	283 days?	Wed 8/10/05
38	(6) Concrete Foundations	5 days?	Mon 8/22/05
39	(6) SOG Concrete	78 days?	Thu 9/1/05
40	(6) Structural Steel Erection	166 days?	Thu 12/22/05
41	(6) Metal Decking	126 days?	Mon 2/20/06
42	**Area 2 - Center Court**	**92 days?**	**Tue 8/8/06**
43	(2) Concrete Foundations	2 days	Tue 8/15/06
44	(2) Structural Steel Erection	2 days	Thu 8/17/06
45	(2) Metal Decking	1 day?	Thu 9/7/06
46	(2) SOD Elevated Concrete	29 days?	Tue 8/8/06
47	(2) Block Masonry	84 days?	Fri 8/18/06
48	(2) SOG Concrete	4 days?	Wed 10/11/06



Project: T.C. Williams High School
Structural Schedule
Date: April 12, 2007



APPENDIX D

Phase A

Structural Redesign Schedule

T.C. Williams High School

Replacement Project

ID		Task Name	Duration	Start
1				
2		**Current Schedule**	**395 days?**	**Thu 6/9/05**
3				
4		(3) Concrete Foundations	37 days?	Wed 6/29/05
5		(3) Block Masonry	239 days?	Mon 8/1/05
6		(3) Structural Steel Erection	48 days?	Wed 12/21/05
7				
8		(7) Concrete Foundations	183 days?	Wed 6/15/05
9		(7) Block Masonry	333 days?	Mon 7/25/05
10		(7) Structural Steel Erection	179 days?	Mon 12/12/05
11				
12		(4) Concrete Foundations	101 days?	Thu 6/9/05
13		(4) Block Masonry	259 days?	Mon 8/15/05
14		(4) Structural Steel Erection	105 days?	Mon 10/31/05
15				
16		(5) Concrete Foundations	156 days?	Fri 7/8/05
17		(5) Block Masonry	301 days?	Mon 7/18/05
18		(5) Structural Steel Erection	159 days?	Wed 12/28/05
19				
20		(1) Concrete Foundations	46 days?	Mon 8/15/05
21		(1) Block Masonry	251 days?	Mon 8/15/05
22		(1) Structural Steel Erection	84 days?	Mon 3/6/06
23				
24		(6) Concrete Foundations	5 days?	Mon 8/1/05
25		(6) Block Masonry	283 days?	Wed 8/10/05
26		(6) Concrete Foundations	5 days?	Mon 8/22/05
27		(6) Structural Steel Erection	166 days?	Thu 12/22/05
28				
29		(2) Concrete Foundations	2 days	Tue 8/15/06
30		(2) Structural Steel Erection	2 days	Thu 8/17/06
31		(2) Block Masonry	84 days?	Fri 8/18/06
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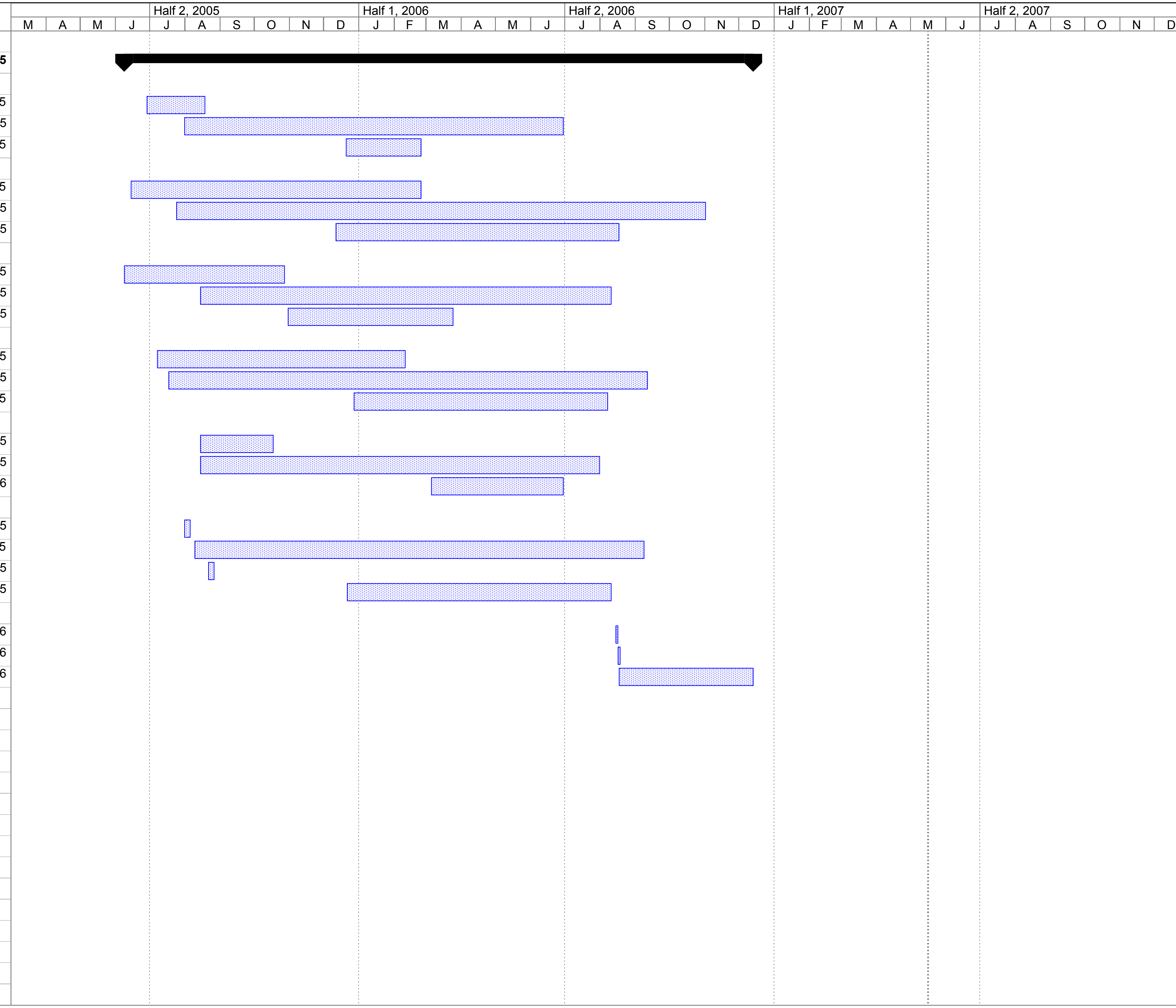

Project: T.C. Williams High School Structural Resequence Scl
Date: April 12, 2007

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

ID		Task Name	Duration	Start
47				
48		**Current Sequence**	**395 days?**	**Thu 6/9/05**
49				
50		(4) Concrete Foundations	101 days?	Thu 6/9/05
51		(7) Concrete Foundations	183 days?	Wed 6/15/05
52		(3) Concrete Foundations	37 days?	Wed 6/29/05
53		(5) Concrete Foundations	156 days?	Fri 7/8/05
54		(6) Concrete Foundations	5 days?	Mon 8/1/05
55		(1) Concrete Foundations	46 days?	Mon 8/15/05
56		(2) Concrete Foundations	2 days	Tue 8/15/06
57				
58		(5) Block Masonry	301 days?	Mon 7/18/05
59		(7) Block Masonry	333 days?	Mon 7/25/05
60		(3) Block Masonry	239 days?	Mon 8/1/05
61		(6) Block Masonry	283 days?	Wed 8/10/05
62		(4) Block Masonry	259 days?	Mon 8/15/05
63		(1) Block Masonry	251 days?	Mon 8/15/05
64		(2) Block Masonry	84 days?	Fri 8/18/06
65				
66				
67		(4) Structural Steel Erection	105 days?	Mon 10/31/05
68		(7) Structural Steel Erection	179 days?	Mon 12/12/05
69		(3) Structural Steel Erection	48 days?	Wed 12/21/05
70		(6) Structural Steel Erection	166 days?	Thu 12/22/05
71		(5) Structural Steel Erection	159 days?	Wed 12/28/05
72		(1) Structural Steel Erection	84 days?	Mon 3/6/06
73				
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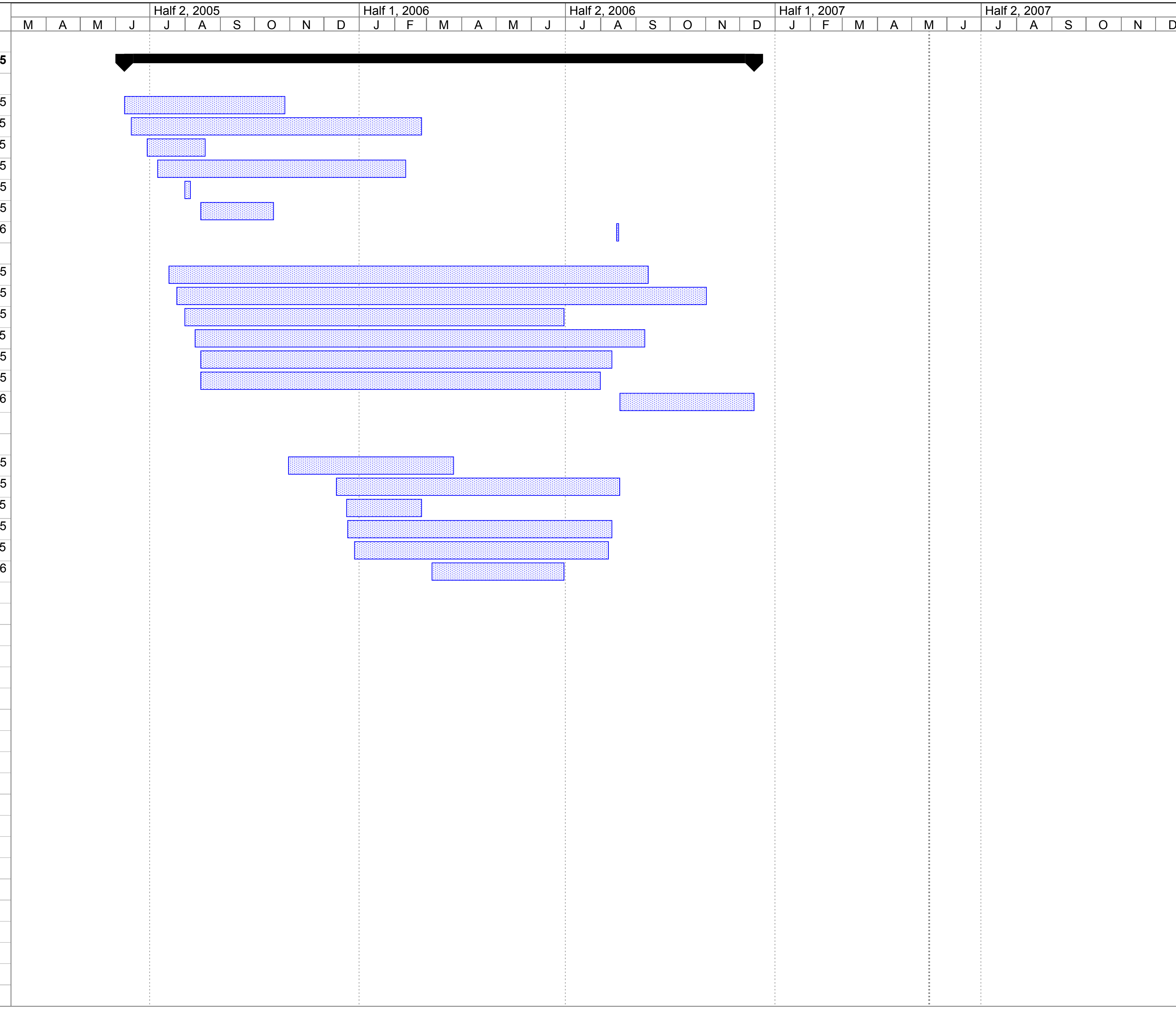

Project: T.C. Williams High School
Structural Resequence Scl
Date: April 12, 2007

Task	Progress	Summary	External Tasks	Deadline
Split	Milestone	Project Summary	External Milestone	

ID	Task Name	Duration	Start
93			
94	**Proposed - CMU Schedule**	**647 days?**	**Thu 6/9/05**
95			
96	(7) Concrete Foundations	183 days	Thu 6/9/05
97	(7) Block Masonry	218 days	Thu 6/16/05
98	(7) Structural Steel Erection	100 days?	Mon 12/12/05
99			
100	(3) Concrete Foundations	37 days	Wed 6/15/05
101	(3) Block Masonry	239 days	Wed 6/22/05
102	(3) Structural Steel Erection	48 days	Wed 6/22/05
103			
104	(2) Concrete Foundations	5 days	Thu 8/4/05
105	(2) Block Masonry	84 days	Wed 8/10/05
106	(2) Structural Steel Erection	14 days	Mon 8/29/05
107			
108	(4) Concrete Foundations	101 days	Thu 8/4/05
109	(4) Block Masonry	259 days?	Mon 8/15/05
110	(4) Structural Steel Erection	105 days	Mon 8/29/05
111			
112	(1) Concrete Foundations	46 days	Wed 8/10/05
113	(1) Block Masonry	251 days	Mon 12/5/05
114	(1) Structural Steel Erection	84 days	Mon 1/23/06
115			
116	(6) Concrete Foundations	5 days?	Mon 12/26/05
117	(6) Block Masonry	82 days	Mon 1/2/06
118	(6) Structural Steel Erection	25 days	Wed 4/26/06
119			
120	(5) Concrete Foundations	156 days	Mon 1/2/06
121	(5) Block Masonry	396 days	Tue 4/25/06
122	(5) Structural Steel Erection	55 days	Mon 9/17/07
123			
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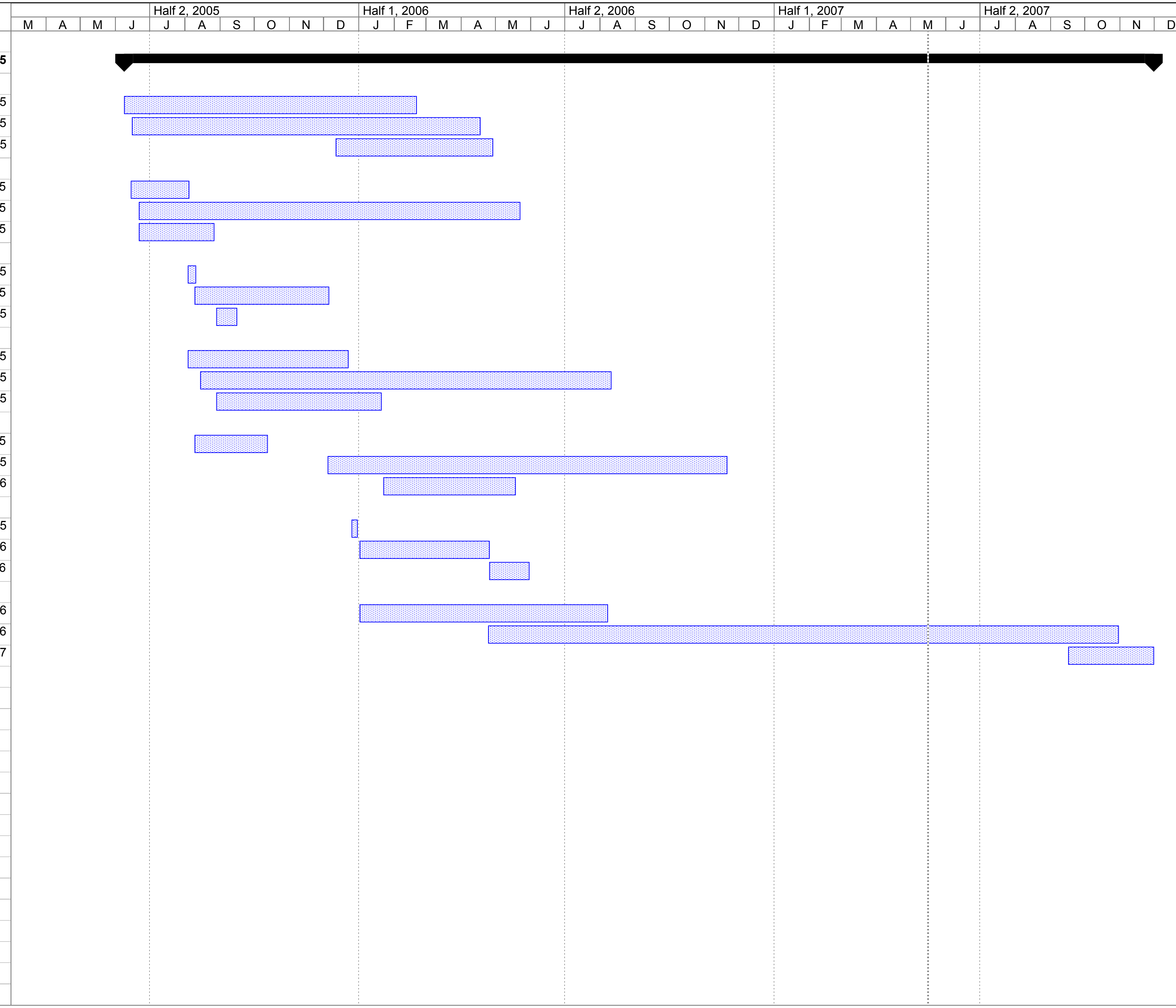

Project: T.C. Williams High School Structural Resequence Scl
Date: April 12, 2007

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

ID		Task Name	Duration	Start
139				
140		**Proposed - CMU Sequence**	**647 days?**	**Thu 6/9/05**
141				
142		(7) Concrete Foundations	183 days	Thu 6/9/05
143		(3) Concrete Foundations	37 days	Wed 6/15/05
144		(2) Concrete Foundations	5 days	Thu 8/4/05
145		(4) Concrete Foundations	101 days	Thu 8/4/05
146		(1) Concrete Foundations	46 days	Wed 8/10/05
147		(6) Concrete Foundations	5 days?	Mon 12/26/05
148		(5) Concrete Foundations	156 days	Mon 1/2/06
149				
150		(7) Block Masonry	218 days	Thu 6/16/05
151		(3) Block Masonry	239 days	Wed 6/22/05
152		(2) Block Masonry	84 days	Wed 8/10/05
153		(4) Block Masonry	259 days?	Mon 8/15/05
154		(1) Block Masonry	251 days	Mon 12/5/05
155		(6) Block Masonry	82 days	Mon 1/2/06
156		(5) Block Masonry	396 days	Tue 4/25/06
157				
158		(7) Structural Steel Erection	100 days?	Mon 12/12/05
159		(3) Structural Steel Erection	48 days	Wed 6/22/05
160		(2) Structural Steel Erection	14 days	Mon 8/29/05
161		(4) Structural Steel Erection	105 days	Mon 8/29/05
162		(1) Structural Steel Erection	84 days	Mon 1/23/06
163		(6) Structural Steel Erection	25 days	Wed 4/26/06
164		(5) Structural Steel Erection	55 days	Mon 9/17/07
165				
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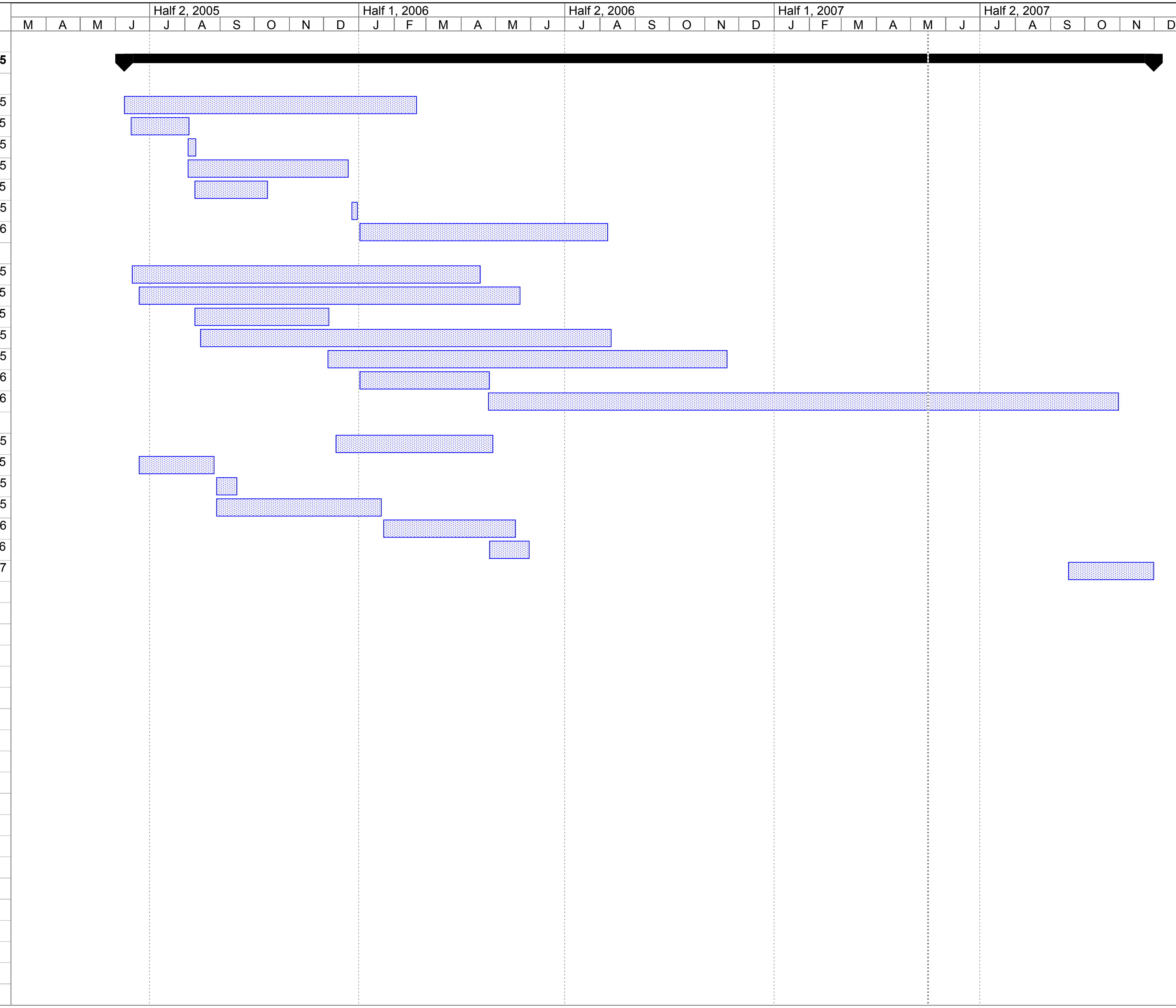

Project: T.C. Williams High School
Structural Resequence Scl
Date: April 12, 2007

Task		Progress		Summary		External Tasks		Deadline	
Split		Milestone		Project Summary		External Milestone			

ID		Task Name	Duration	Start
185				
186		**Proposed - Solarcrete System Schedule**	**378 days?**	**Thu 6/9/05**
187				
188		(7) Concrete Foundations	183 days	Thu 6/9/05
189		(7) Solarcrete Panels	52 days	Wed 3/22/06
190		(7) Structural Steel Erection	55 days	Fri 5/19/06
191				
192		(3) Concrete Foundations	37 days	Wed 6/15/05
193		(3) Block Masonry	239 days	Wed 6/22/05
194		(3) Structural Steel Erection	48 days	Wed 6/22/05
195				
196		(2) Concrete Foundations	5 days	Thu 8/4/05
197		(2) Block Masonry	84 days	Wed 8/10/05
198		(2) Structural Steel Erection	14 days	Mon 8/29/05
199				
200		(4) Concrete Foundations	101 days	Thu 8/4/05
201		(4) Block Masonry	259 days?	Mon 8/15/05
202		(4) Structural Steel Erection	105 days	Mon 8/29/05
203				
204		(1) Concrete Foundations	46 days	Wed 8/10/05
205		(1) Block Masonry	251 days	Mon 12/5/05
206		(1) Structural Steel Erection	84 days	Mon 1/23/06
207				
208		(6) Concrete Foundations	6 days	Thu 5/25/06
209		(6) Solarcrete Panels	28 days	Thu 6/1/06
210		(6) Structural Steel Erection	20 days	Thu 8/3/06
211				
212		(5) Concrete Foundations	156 days	Mon 1/2/06
213		(5) Solarcrete Panels	80 days	Mon 7/10/06
214		(5) Structural Steel Erection	55 days	Wed 8/30/06
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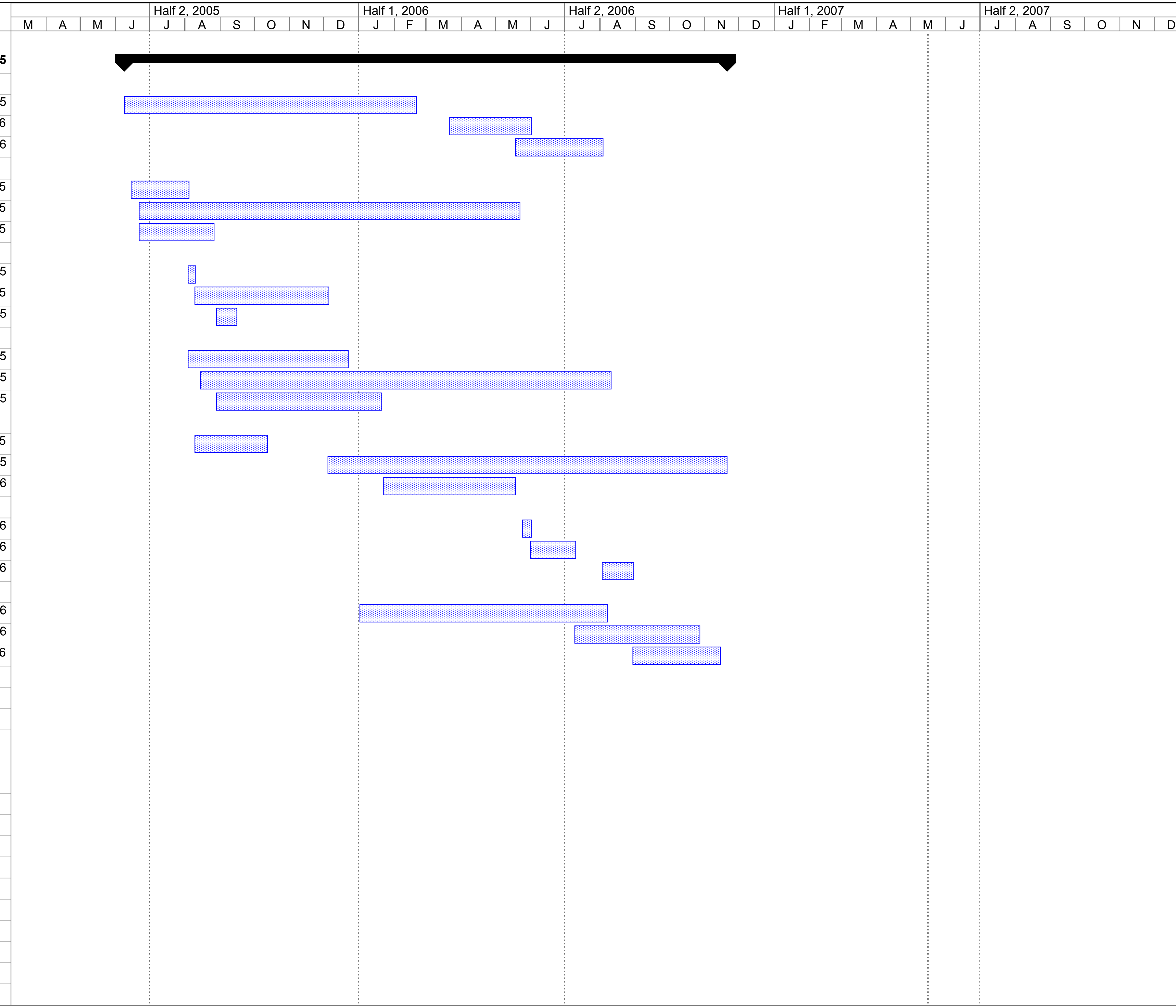
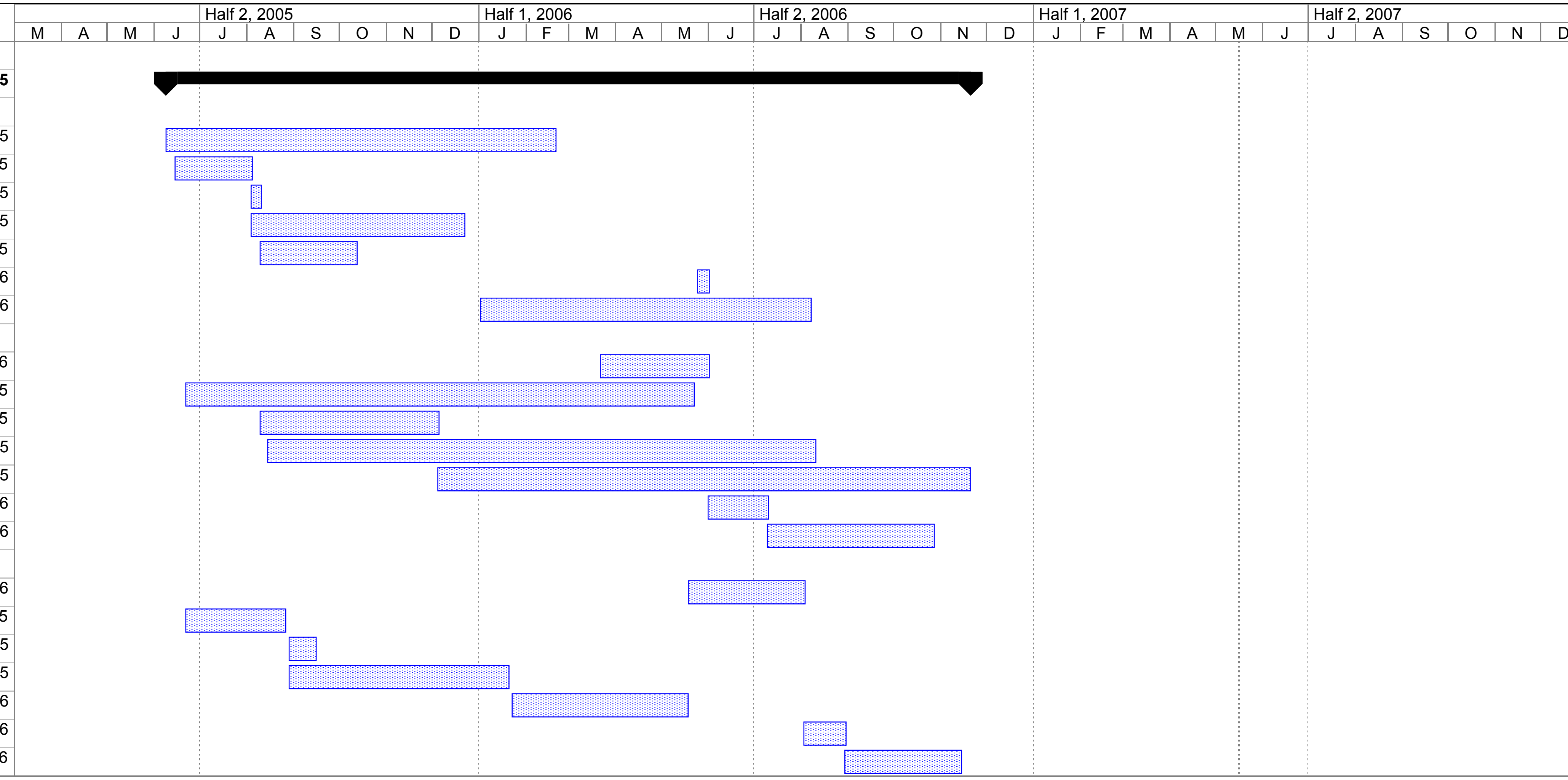


Project: T.C. Williams High School
Structural Resequence Scl
Date: April 12, 2007

Task		Progress		Summary		External Tasks		Deadline	
Split		Milestone		Project Summary		External Milestone			

ID		Task Name	Duration	Start
231				
232		**Proposed - Solarcrete Sequence**	**378 days?**	**Thu 6/9/05**
233				
234		(7) Concrete Foundations	183 days	Thu 6/9/05
235		(3) Concrete Foundations	37 days	Wed 6/15/05
236		(2) Concrete Foundations	5 days	Thu 8/4/05
237		(4) Concrete Foundations	101 days	Thu 8/4/05
238		(1) Concrete Foundations	46 days	Wed 8/10/05
239		(6) Concrete Foundations	6 days	Thu 5/25/06
240		(5) Concrete Foundations	156 days	Mon 1/2/06
241				
242		(7) Solarcrete Panels	52 days	Wed 3/22/06
243		(3) Block Masonry	239 days	Wed 6/22/05
244		(2) Block Masonry	84 days	Wed 8/10/05
245		(4) Block Masonry	259 days?	Mon 8/15/05
246		(1) Block Masonry	251 days	Mon 12/5/05
247		(6) Solarcrete Panels	28 days	Thu 6/1/06
248		(5) Solarcrete Panels	80 days	Mon 7/10/06
249				
250		(7) Structural Steel Erection	55 days	Fri 5/19/06
251		(3) Structural Steel Erection	48 days	Wed 6/22/05
252		(2) Structural Steel Erection	14 days	Mon 8/29/05
253		(4) Structural Steel Erection	105 days	Mon 8/29/05
254		(1) Structural Steel Erection	84 days	Mon 1/23/06
255		(6) Structural Steel Erection	20 days	Thu 8/3/06
256		(5) Structural Steel Erection	55 days	Wed 8/30/06



Project: T.C. Williams High School
Structural Resequence Scl
Date: April 12, 2007

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

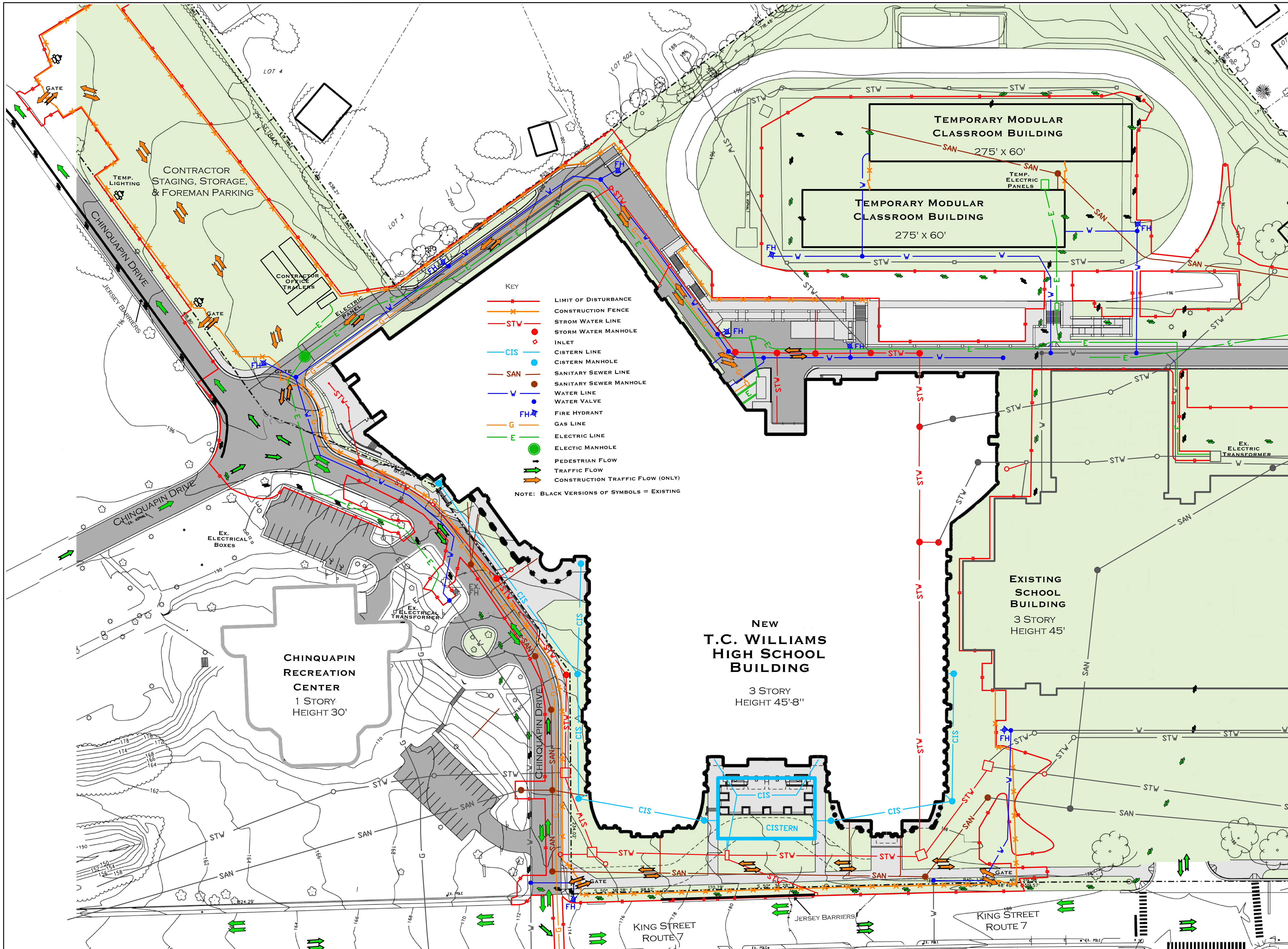
Appendix E

Existing Conditions

Site Plan

T.C. Williams High School

Replacement Project



T.C. WILLIAMS HIGH SCHOOL REPLACEMENT PROJECT

OWNER:
ALEXANDRIA CITY PUBLIC SCHOOLS

LOCATION:
3330 KING STREET
ALEXANDRIA, VA 22302

MARK	DATE	DESCRIPTION
1	04/12/07	FINAL REPORT

PROJECT NO:

REVIEWED BY:

DRAWN BY: KYLE CONRAD

SCALE: 1/96" = 1'

SHEET TITLE:

EXISTING CONDITIONS SITE PLAN

C-100

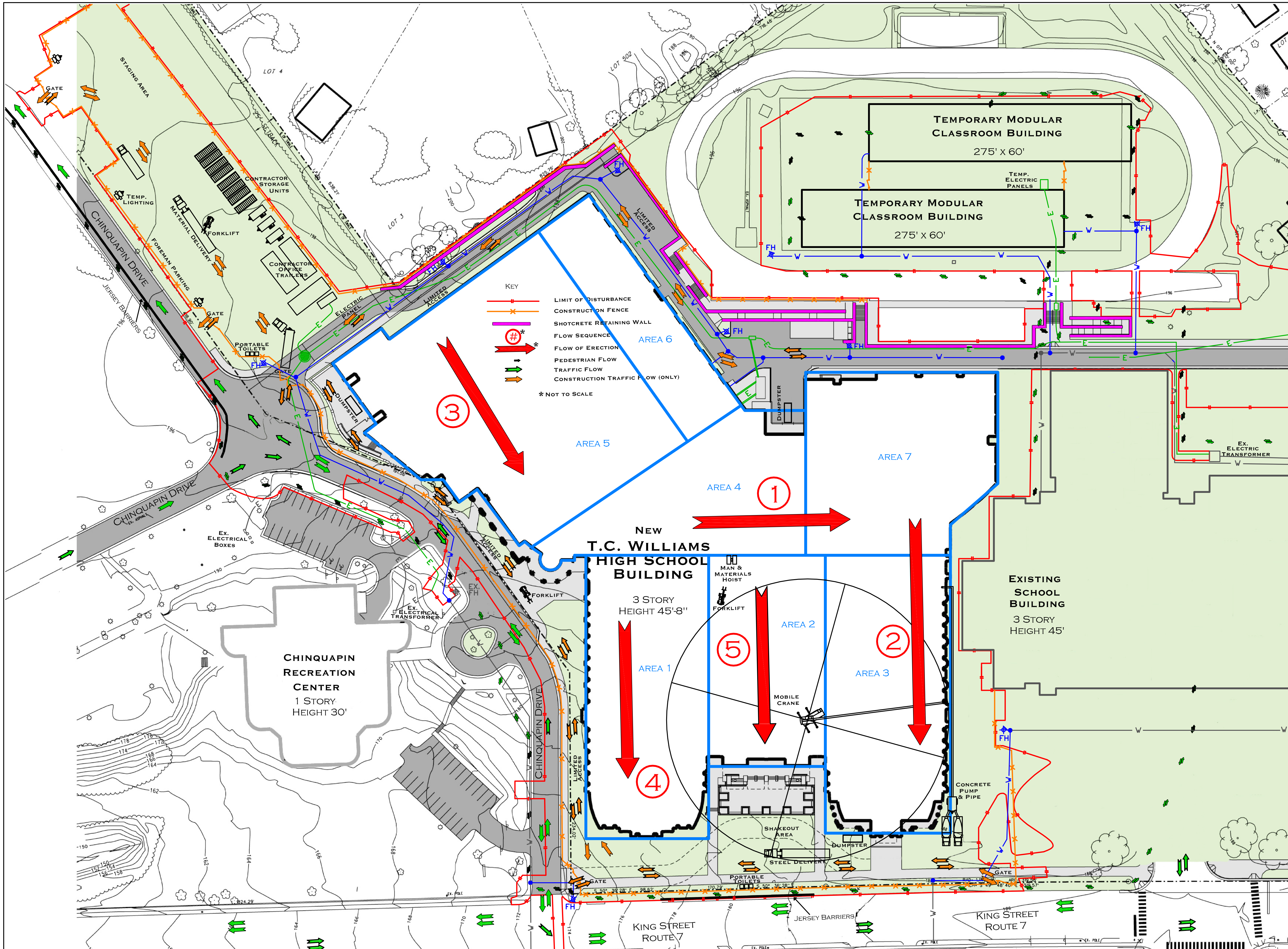
Appendix F

Superstructure

Site Logistics Plan

T.C. Williams High School

Replacement Project



T.C. WILLIAMS HIGH SCHOOL REPLACEMENT PROJECT

OWNER:
ALEXANDRIA CITY PUBLIC SCHOOLS

LOCATION:
3330 KING STREET
ALEXANDRIA, VA 22302

MARK	DATE	DESCRIPTION
3	04/12/07	FINAL REPORT
2	10/20/06	TECH ASSIGN. #2
1	10/06/06	TECH ASSIGN. #1

PROJECT NO:
REVIEWED BY:
DRAWN BY: KYLE CONRAD
SCALE: 1/96" = 1'

SHEET TITLE:
SUPERSTRUCTURE SITE PLAN

C-101

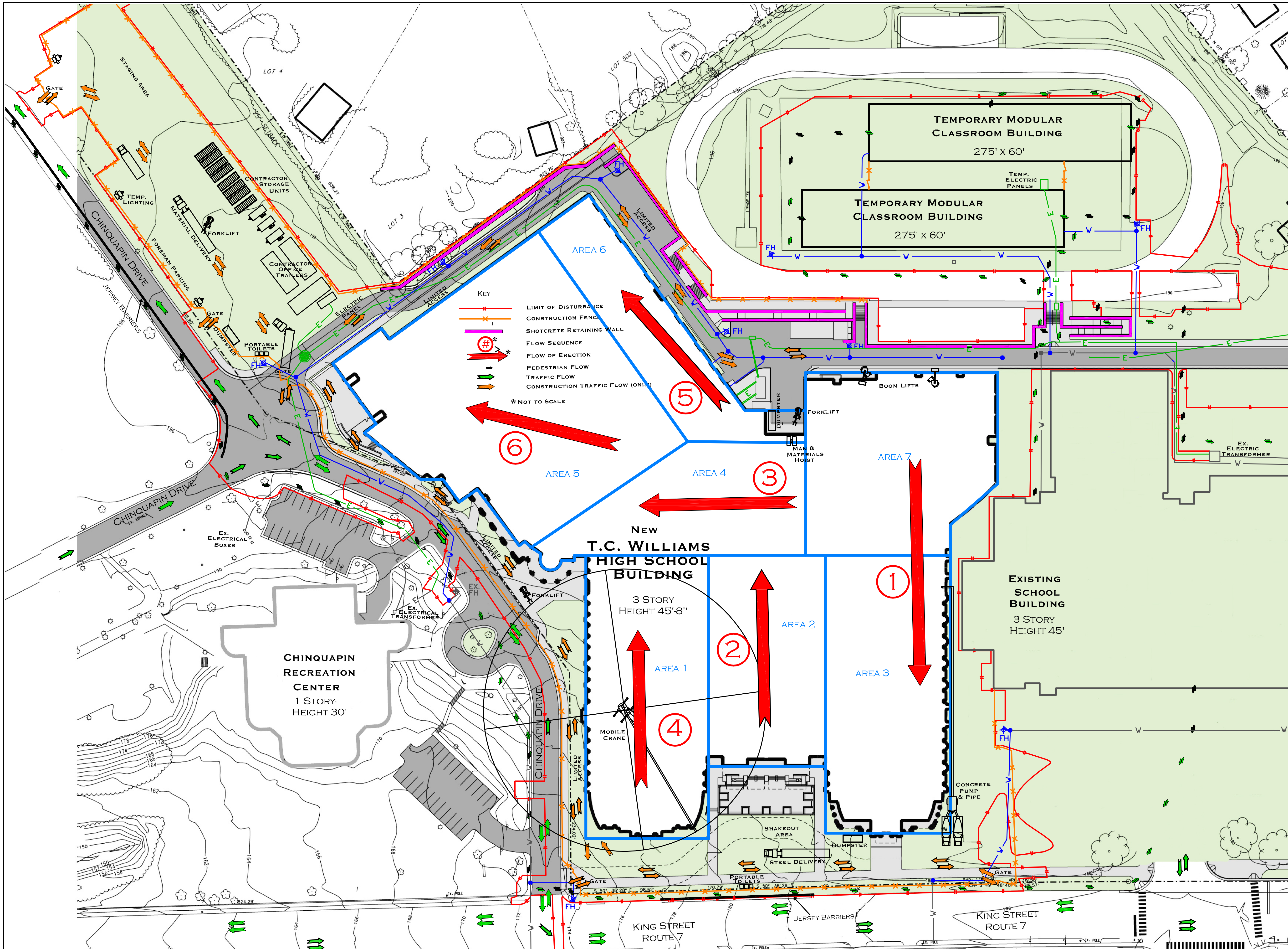
APPENDIX G

Re-Sequenced Superstructure

Site Logistics Plan

T.C. Williams High School

Replacement Project



T.C. WILLIAMS HIGH SCHOOL REPLACEMENT PROJECT

OWNER:
ALEXANDRIA CITY PUBLIC SCHOOLS

LOCATION:
3330 KING STREET
ALEXANDRIA, VA 22302

MARK	DATE	DESCRIPTION
3	04/12/07	FINAL REPORT
2	10/20/06	TECH ASSIGN. #2
1	10/06/06	TECH ASSIGN. #1

PROJECT NO.:

REVIEWED BY:

DRAWN BY: KYLE CONRAD

SCALE: 1/96" = 1'

SHEET TITLE:

RESEQUENCED SUPERSTRUCTURE SITE PLAN

C-102

Appendix H

Area 5

Gymnasium Reverberation Calculations

T.C. Williams High School

Replacement Project

Reverberation Time Calculator

$T_{60} = .05(V/a) = .05(V/\sum S\alpha)$

Reverberation Time Calculation for :		T.C. Williams High School Main Gymnasium Open Gym - Bleachers Retracted King Street - Alexandria, VA				
CMU Walls						
			Absorption Coefficient		**Sα**	
Surface	**Material**	**Area (ft^2)**	**500 Hz**	**1000 Hz**	**500 Hz**	**1000 Hz**
Floor	Athletic Wood Flooring	24,563.00	0.07	0.06	1719.41	1473.78
Ceiling	3" Deep Acoustical Roof Deck	24,563.00	0.89	0.95	21861.07	23334.85
North Wall	Ground Face CMU - Painted	1,365.33	0.06	0.07	81.9198	95.5731
North Wall	Wood Bleachers	2,626.00	0.22	0.39	577.72	1024.14
North Wall	Metal Doors	42.00	0.10	0.10	4.2	4.2
South Wall	Ground Face CMU - Painted	1,323.33	0.06	0.07	79.3998	92.6331
South Wall	Wood Bleachers	2,626.00	0.22	0.39	577.72	1024.14
South Wall	Metal Doors	84.00	0.10	0.10	8.4	8.4
West Wall	Ground Face CMU - Painted	4,315.78	0.06	0.07	258.9468	302.1046
West Wall	Acoustical CMU	1,872.66	0.97	0.80	1816.48	1498.128
West Wall	Metal Doors	168.00	0.10	0.10	16.8	16.8
West Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
West Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
East Wall	Ground Face CMU - Painted	4,105.78	0.06	0.07	246.3468	287.4046
East Wall	Acoustical CMU	1,872.66	0.97	0.80	1816.48	1498.128
East Wall	Metal Doors	378.00	0.10	0.10	37.8	37.8
East Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
East Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
Room Length (ft) :	203.00	ft	**$a = \sum S\alpha$**		29492.29	31084.53
Room Width (ft) :	121.00	ft	**$T_{60} = .05(V/\sum S\alpha)$**		**1.39**	**1.32**
Room Height (ft) :	33.33	ft				
Volume (ft^3) :	**818,685**	ft^3				

Target Reverberation Time: Gymnasium for Teaching*	1.5 to 1.8	1.5 to 1.8

* Target Reverberation Time obtained from the M[c] Squared System Design Group, Inc.

Reverberation Time Calculator

$$T_{60} = .05(V/a) = .05(V/\sum S\alpha)$$

Reverberation Time Calculation for :	T.C. Williams High School Main Gymnasium Open Gym - 3/4 Occupancy King Street - Alexandria, VA					
CMU Walls						
			Absorption Coefficient		Sα	
Surface	**Material**	**Area (ft^2)**	**500 Hz**	**1000 Hz**	**500 Hz**	**1000 Hz**
Floor	Athletic Wood Flooring	11,979.00	0.07	0.06	838.53	718.74
Floor	3/4 Students, On Bleachers	9,438.00	0.49	0.84	4624.62	7927.92
Floor	1/4 Wood Bleachers	3,146.00	0.22	0.39	692.12	1226.94
Ceiling	3" Deep Acoustical Roof Deck	24,563.00	0.89	0.95	21861.07	23334.85
North Wall	Ground Face CMU - Painted	1,365.33	0.06	0.07	81.9198	95.5731
North Wall	3/4 Students, On Bleachers	1,969.50	0.49	0.84	965.055	1654.38
North Wall	1/4 Wood Bleachers	656.50	0.22	0.39	144.43	256.035
North Wall	Metal Doors	42.00	0.10	0.10	4.2	4.2
South Wall	Ground Face CMU - Painted	1,323.33	0.06	0.07	79.3998	92.6331
South Wall	3/4 Students, On Bleachers	1,969.50	0.49	0.84	965.055	1654.38
South Wall	1/4 Wood Bleachers	656.50	0.22	0.39	144.43	256.035
South Wall	Metal Doors	84.00	0.10	0.10	8.4	8.4
West Wall	Ground Face CMU - Painted	4,315.78	0.06	0.07	258.9468	302.1046
West Wall	Acoustical CMU	1,872.66	1.02	0.72	1910.113	1348.315
West Wall	Metal Doors	168.00	0.10	0.10	16.8	16.8
West Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
West Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
East Wall	Ground Face CMU - Painted	4,105.78	0.06	0.07	246.3468	287.4046
East Wall	Acoustical CMU	1,872.66	1.02	0.72	1910.113	1348.315
East Wall	Metal Doors	378.00	0.10	0.10	37.8	37.8
East Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
East Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
					0	0
					0	0
					0	0
Room Length (ft) :	203.00	ft	$a = \sum S\alpha$		35178.95	40957.28
Room Width (ft) :	121.00	ft	$T_{60} = .05(V/\sum S\alpha)$		**1.16**	**1.00**
Room Height (ft) :	33.33	ft				
Volume (ft^3) :	**818,685**	ft^3				

Target Reverberation Time: Gymnasium for Teaching*	1.5 to 1.8	1.5 to 1.8

* Target Reverberation Time obtained from the M^c Squared System Design Group, Inc.

Reverberation Time Calculator

$T_{60} = .05(V/a) = .05(V/\sum S\alpha)$

Reverberation Time Calculation for :		T.C. Williams High School Main Gymnasium Open Gym - Full Occupancy King Street - Alexandria, VA				
CMU Walls						
			Absorption Coefficient		Sα	
Surface	Material	Area (ft^2)	500 Hz	1000 Hz	500 Hz	1000 Hz
Floor	Athletic Wood Flooring	11,979.00	0.07	0.06	838.53	718.74
Floor	Students, On Bleachers	12,584.00	0.49	0.84	6166.16	10570.56
Ceiling	3" Deep Acoustical Roof Deck	24,563.00	0.89	0.95	21861.07	23334.85
North Wall	Ground Face CMU - Painted	1,365.33	0.06	0.07	81.9198	95.5731
North Wall	Students, On Bleachers	2,626.00	0.49	0.84	1286.74	2205.84
North Wall	Metal Doors	42.00	0.10	0.10	4.2	4.2
South Wall	Ground Face CMU - Painted	1,323.33	0.06	0.07	79.3998	92.6331
South Wall	Students, On Bleachers	2,626.00	0.49	0.84	1286.74	2205.84
South Wall	Metal Doors	84.00	0.10	0.10	8.4	8.4
West Wall	Ground Face CMU - Painted	4,315.78	0.06	0.07	258.9468	302.1046
West Wall	Acoustical CMU	1,872.66	1.02	0.72	1910.113	1348.315
West Wall	Metal Doors	168.00	0.10	0.10	16.8	16.8
West Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
West Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
East Wall	Ground Face CMU - Painted	4,105.78	0.06	0.07	246.3468	287.4046
East Wall	Acoustical CMU	1,872.66	1.02	0.72	1910.113	1348.315
East Wall	Metal Doors	378.00	0.10	0.10	37.8	37.8
East Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
East Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
Room Length (ft) :	203.00	ft	$a = \sum S\alpha$		36382.88	42963.83
Room Width (ft) :	121.00	ft	$T_{60} = .05(V/\sum S\alpha)$		1.13	0.95
Room Height (ft) :	33.33	ft				
Volume (ft^3) :	**818,685**	ft^3				

Target Reverberation Time: Gymnasium for Teaching*	1.5 to 1.8	1.5 to 1.8

* Target Reverberation Time obtained from the M[c] Squared System Design Group, Inc.

Reverberation Time Calculator

$T_{60} = .05(V/a) = .05(V/\sum S\alpha)$

Reverberation Time Calculation for :		T.C. Williams High School Main Gymnasium Open Gym - Bleachers Retracted				
Solarcrete System - w/o Acoustic Wall Panels		King Street - Alexandria, VA				
			Absorption Coefficient		Sα	
Surface	**Material**	**Area (ft^2)**	**500 Hz**	**1000 Hz**	**500 Hz**	**1000 Hz**
Floor	Athletic Wood Flooring	24,563.00	0.07	0.06	1719.41	1473.78
Ceiling	3" Deep Acoustical Roof Deck	24,563.00	0.89	0.95	21861.07	23334.85
North Wall	Concrete, Troweled	1,365.33	0.02	0.02	27.3066	27.3066
North Wall	Wood Bleachers	2,626.00	0.22	0.39	577.72	1024.14
North Wall	Metal Doors	42.00	0.10	0.10	4.2	4.2
South Wall	Concrete, Troweled	1,323.33	0.02	0.02	26.4666	26.4666
South Wall	Wood Bleachers	2,626.00	0.22	0.39	577.72	1024.14
South Wall	Metal Doors	84.00	0.10	0.10	8.4	8.4
West Wall	Concrete, Troweled	6,188.44	0.02	0.02	123.7688	123.7688
West Wall	Metal Doors	168.00	0.10	0.10	16.8	16.8
West Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
West Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
East Wall	Concrete, Troweled	5,978.44	0.02	0.02	119.5688	119.5688
East Wall	Metal Doors	378.00	0.10	0.10	37.8	37.8
East Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
East Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
Room Length (ft) :	203.00	ft	**$a = \sum S\alpha$**		25489.83	27607.67
Room Width (ft) :	121.00	ft	**$T_{60} = .05(V/\sum S\alpha)$**		**1.61**	**1.48**
Room Height (ft) :	33.33	ft				
Volume (ft^3) :	**818,685**	ft^3				

Target Reverberation Time: Gymnasium for Teaching*	500 Hz	1000 Hz
	1.5 to 1.8	1.5 to 1.8

* Target Reverberation Time obtained from the M[c] Squared System Design Group, Inc.

Reverberation Time Calculator

$$T_{60} = .05(V/a) = .05(V/\sum S\alpha)$$

Reverberation Time Calculation for :	T.C. Williams High School Main Gymnasium					
	Open Gym - 3/4 Occupancy					
Solarcrete System - w/o Acoustic Wall Panels	King Street - Alexandria, VA					
			Absorption Coefficient		Sα	
Surface	Material	Area (ft^2)	500 Hz	1000 Hz	500 Hz	1000 Hz
Floor	Athletic Wood Flooring	11,979.00	0.07	0.06	838.53	718.74
Floor	3/4 Students, On Bleachers	9,438.00	0.49	0.84	4624.62	7927.92
Floor	1/4 Wood Bleachers	3,146.00	0.22	0.39	692.12	1226.94
Ceiling	3" Deep Acoustical Roof Deck	24,563.00	0.89	0.95	21861.07	23334.85
North Wall	Concrete, Troweled	1,365.33	0.02	0.02	27.3066	27.3066
North Wall	3/4 Students, On Bleachers	1,969.50	0.49	0.84	965.055	1654.38
North Wall	1/4 Wood Bleachers	656.50	0.22	0.39	144.43	256.035
North Wall	Metal Doors	42.00	0.10	0.10	4.2	4.2
South Wall	Concrete, Troweled	1,323.33	0.02	0.02	26.4666	26.4666
South Wall	3/4 Students, On Bleachers	1,969.50	0.49	0.84	965.055	1654.38
South Wall	1/4 Wood Bleachers	656.50	0.22	0.39	144.43	256.035
South Wall	Metal Doors	84.00	0.10	0.10	8.4	8.4
West Wall	Concrete, Troweled	6,188.44	0.02	0.02	123.7688	123.7688
West Wall	Metal Doors	168.00	0.10	0.10	16.8	16.8
West Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
West Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
East Wall	Concrete, Troweled	5,978.44	0.02	0.02	119.5688	119.5688
East Wall	Metal Doors	378.00	0.10	0.10	37.8	37.8
East Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
East Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
					0	0
					0	0
					0	0
					0	0
					0	0
Room Length (ft) :	203.00	ft	$a = \sum S\alpha$		30989.22	37780.04
Room Width (ft) :	121.00	ft	$T_{60} = .05(V/\sum S\alpha)$		1.32	1.08
Room Height (ft) :	33.33	ft				
Volume (ft^3) :	818,685	ft^3				

Target Reverberation Time: Gymnasium for Teaching*	1.5 to 1.8	1.5 to 1.8

* Target Reverberation Time obtained from the M^c Squared System Design Group, Inc.

Reverberation Time Calculator

$T_{60} = .05(V/a) = .05(V/\sum S\alpha)$

Reverberation Time Calculation for :	T.C. Williams High School Main Gymnasium Open Gym - Full Occupancy					
Solarcrete System - w/o Acoustic Wall Panels	King Street - Alexandria, VA					
			Absorption Coefficient		Sα	
Surface	**Material**	**Area (ft^2)**	**500 Hz**	**1000 Hz**	**500 Hz**	**1000 Hz**
Floor	Athletic Wood Flooring	11,979.00	0.07	0.06	838.53	718.74
Floor	Students, On Bleachers	12,584.00	0.49	0.84	6166.16	10570.56
Ceiling	3" Deep Acoustical Roof Deck	24,563.00	0.89	0.95	21861.07	23334.85
North Wall	Concrete, Troweled	1,365.33	0.02	0.02	27.3066	27.3066
North Wall	Students, On Bleachers	2,626.00	0.49	0.84	1286.74	2205.84
North Wall	Metal Doors	42.00	0.10	0.10	4.2	4.2
South Wall	Concrete, Troweled	1,323.33	0.02	0.02	26.4666	26.4666
South Wall	Students, On Bleachers	2,626.00	0.49	0.84	1286.74	2205.84
South Wall	Metal Doors	84.00	0.10	0.10	8.4	8.4
West Wall	Concrete, Troweled	6,188.44	0.02	0.02	123.7688	123.7688
West Wall	Metal Doors	168.00	0.10	0.10	16.8	16.8
West Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
West Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
East Wall	Concrete, Troweled	5,978.44	0.02	0.02	119.5688	119.5688
East Wall	Metal Doors	378.00	0.10	0.10	37.8	37.8
East Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
East Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
Room Length (ft) :	203.00	ft	$a = \sum S\alpha$		32193.15	39786.59
Room Width (ft) :	121.00	ft	$T_{60} = .05(V/\sum S\alpha)$		**1.27**	**1.03**
Room Height (ft) :	33.33	ft				
Volume (ft^3) :	**818,685**	ft^3				

Target Reverberation Time: Gymnasium for Teaching*	1.5 to 1.8	1.5 to 1.8

* Target Reverberation Time obtained from the M[c] Squared System Design Group, Inc.

Reverberation Time Calculator

$T_{60} = .05(V/a) = .05(V/\sum S\alpha)$

Reverberation Time Calculation for :		T.C. Williams High School Main Gymnasium				
Solarcrete System - w/ Soft Sound™ Acoustic Wall Panels		Open Gym - Bleachers Retracted King Street - Alexandria, VA				
			Absorption Coefficient		Sα	
Surface	**Material**	**Area (ft^2)**	**500 Hz**	**1000 Hz**	**500 Hz**	**1000 Hz**
Floor	Athletic Wood Flooring	24,563.00	0.07	0.06	1719.41	1473.78
Ceiling	3" Deep Acoustical Roof Deck	24,563.00	0.89	0.95	21861.07	23334.85
North Wall	Concrete, Troweled	1,365.33	0.02	0.02	27.3066	27.3066
North Wall	Wood Bleachers	2,626.00	0.22	0.39	577.72	1024.14
North Wall	Metal Doors	42.00	0.10	0.10	4.2	4.2
South Wall	Concrete, Troweled	1,323.33	0.02	0.02	26.4666	26.4666
South Wall	Wood Bleachers	2,626.00	0.22	0.39	577.72	1024.14
South Wall	Metal Doors	84.00	0.10	0.10	8.4	8.4
West Wall	Concrete, Troweled	6,188.44	0.02	0.02	123.7688	123.7688
West Wall	Metal Doors	168.00	0.10	0.10	16.8	16.8
West Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
West Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
East Wall	Concrete, Troweled	5,978.44	0.02	0.02	119.5688	119.5688
East Wall	Metal Doors	378.00	0.10	0.10	37.8	37.8
East Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
East Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
					0	0
West Wall	1" Fabric Impact Resistant Acoustic Panels	2,400.00	0.89	1.07	2136	2568
East Wall	1" Fabric Impact Resistant Acoustic Panels	2,400.00	0.89	1.07	2136	2568
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
Room Length (ft) :	203.00	ft	**a = ∑Sα**		29761.83	32743.67
Room Width (ft) :	121.00	ft				
Room Height (ft) :	33.33	ft	**$T_{60} = .05(V/\sum S\alpha)$**		**1.38**	**1.25**
Volume (ft^3) :	**818,685**	ft^3	CMU Reverberation Time		**1.39**	**1.32**

Target Reverberation Time: Gymnasium for Teaching*	1.5 to 1.8	1.5 to 1.8

* Target Reverberation Time obtained from the M[c] Squared System Design Group, Inc.

Reverberation Time Calculator

$T_{60} = .05(V/a) = .05(V/\sum S\alpha)$

Reverberation Time Calculation for :	T.C. Williams High School Main Gymnasium Open Gym - 3/4 Occupancy					
Solarcrete System - w/ Soft Sound™ Acoustic Wall Panels	King Street - Alexandria, VA					
			Absorption Coefficient		Sα	
Surface	**Material**	**Area (ft^2)**	**500 Hz**	**1000 Hz**	**500 Hz**	**1000 Hz**
Floor	Athletic Wood Flooring	11,979.00	0.07	0.06	838.53	718.74
Floor	3/4 Students, On Bleachers	9,438.00	0.49	0.84	4624.62	7927.92
Floor	1/4 Wood Bleachers	3,146.00	0.22	0.39	692.12	1226.94
Ceiling	3" Deep Acoustical Roof Deck	24,563.00	0.89	0.95	21861.07	23334.85
North Wall	Concrete, Troweled	1,365.33	0.02	0.02	27.3066	27.3066
North Wall	3/4 Students, On Bleachers	1,969.50	0.49	0.84	965.055	1654.38
North Wall	1/4 Wood Bleachers	656.50	0.22	0.39	144.43	256.035
North Wall	Metal Doors	42.00	0.10	0.10	4.2	4.2
South Wall	Concrete, Troweled	1,323.33	0.02	0.02	26.4666	26.4666
South Wall	3/4 Students, On Bleachers	1,969.50	0.49	0.84	965.055	1654.38
South Wall	1/4 Wood Bleachers	656.50	0.22	0.39	144.43	256.035
South Wall	Metal Doors	84.00	0.10	0.10	8.4	8.4
West Wall	Concrete, Troweled	6,188.44	0.02	0.02	123.7688	123.7688
West Wall	Metal Doors	168.00	0.10	0.10	16.8	16.8
West Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
West Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
East Wall	Concrete, Troweled	5,978.44	0.02	0.02	119.5688	119.5688
East Wall	Metal Doors	378.00	0.10	0.10	37.8	37.8
East Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
East Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
					0	0
West Wall	1" Fabric Impact Resistant Acoustic Panels	2,400.00	0.89	1.07	2136	2568
East Wall	1" Fabric Impact Resistant Acoustic Panels	2,400.00	0.89	1.07	2136	2568
					0	0
					0	0
Room Length (ft) :	203.00	ft	$a = \sum S\alpha$		35261.22	42916.04
Room Width (ft) :	121.00	ft				
Room Height (ft) :	33.33	ft	$T_{60} = .05(V/\sum S\alpha)$		**1.16**	**0.95**
Volume (ft^3) :	**818,685**	ft^3	CMU Reverberation Time		**1.16**	**1.00**

Target Reverberation Time: Gymnasium for Teaching*	1.5 to 1.8	1.5 to 1.8

* Target Reverberation Time obtained from the M[c] Squared System Design Group, Inc.

Reverberation Time Calculator

$$T_{60} = .05(V/a) = .05(V/\sum S\alpha)$$

Reverberation Time Calculation for :		**T.C. Williams High School Main Gymnasium**				
		Open Gym - Full Occupancy				
Solarcrete System - w/ Soft Sound™ Acoustic Wall Panels		**King Street - Alexandria, VA**				
			Absorption Coefficient		**Sα**	
Surface	**Material**	**Area (ft^2)**	**500 Hz**	**1000 Hz**	**500 Hz**	**1000 Hz**
Floor	Athletic Wood Flooring	11,979.00	0.07	0.06	838.53	718.74
Floor	Students, On Bleachers	12,584.00	0.49	0.84	6166.16	10570.56
Ceiling	3" Deep Acoustical Roof Deck	24,563.00	0.89	0.95	21861.07	23334.85
North Wall	Concrete, Troweled	1,365.33	0.02	0.02	27.3066	27.3066
North Wall	Students, On Bleachers	2,626.00	0.49	0.84	1286.74	2205.84
North Wall	Metal Doors	42.00	0.10	0.10	4.2	4.2
South Wall	Concrete, Troweled	1,323.33	0.02	0.02	26.4666	26.4666
South Wall	Students, On Bleachers	2,626.00	0.49	0.84	1286.74	2205.84
South Wall	Metal Doors	84.00	0.10	0.10	8.4	8.4
West Wall	Concrete, Troweled	6,188.44	0.02	0.02	123.7688	123.7688
West Wall	Metal Doors	168.00	0.10	0.10	16.8	16.8
West Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
West Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
East Wall	Concrete, Troweled	5,978.44	0.02	0.02	119.5688	119.5688
East Wall	Metal Doors	378.00	0.10	0.10	37.8	37.8
East Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
East Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
					0	0
West Wall	1" Fabric Impact Resistant Acoustic Panels	2,400.00	0.89	1.07	2136	2568
East Wall	1" Fabric Impact Resistant Acoustic Panels	2,400.00	0.89	1.07	2136	2568
					0	0
					0	0
					0	0
					0	0
					0	0
Room Length (ft) :	203.00	ft	**$a = \sum S\alpha$**		36465.15	44922.59
Room Width (ft) :	121.00	ft	**$T_{60} = .05(V/\sum S\alpha)$**		**1.12**	**0.91**
Room Height (ft) :	33.33	ft				
Volume (ft^3) :	**818,685**	ft^3	CMU Reverberation Time		**1.13**	**0.95**

Target Reverberation Time: Gymnasium for Teaching*	1.5 to 1.8	1.5 to 1.8

* Target Reverberation Time obtained from the M[c] Squared System Design Group, Inc.

Reverberation Time Calculator

$$T_{60} = .05(V/a) = .05(V/\sum S\alpha)$$

Reverberation Time Calculation for :		**T.C. Williams High School Main Gymnasium**				
Solarcrete System - w/ Fabrisorb™ Acoustic Wall Panels		**Open Gym - Bleachers Retracted** **King Street - Alexandria, VA**				
			Absorption Coefficient		**Sα**	
Surface	**Material**	**Area (ft^2)**	**500 Hz**	**1000 Hz**	**500 Hz**	**1000 Hz**
Floor	Athletic Wood Flooring	24,563.00	0.07	0.06	1719.41	1473.78
Ceiling	3" Deep Acoustical Roof Deck	24,563.00	0.89	0.95	21861.07	23334.85
North Wall	Concrete, Troweled	1,365.33	0.02	0.02	27.3066	27.3066
North Wall	Wood Bleachers	2,626.00	0.22	0.39	577.72	1024.14
North Wall	Metal Doors	42.00	0.10	0.10	4.2	4.2
South Wall	Concrete, Troweled	1,323.33	0.02	0.02	26.4666	26.4666
South Wall	Wood Bleachers	2,626.00	0.22	0.39	577.72	1024.14
South Wall	Metal Doors	84.00	0.10	0.10	8.4	8.4
West Wall	Concrete, Troweled	6,188.44	0.02	0.02	123.7688	123.7688
West Wall	Metal Doors	168.00	0.10	0.10	16.8	16.8
West Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
West Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
East Wall	Concrete, Troweled	5,978.44	0.02	0.02	119.5688	119.5688
East Wall	Metal Doors	378.00	0.10	0.10	37.8	37.8
East Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
East Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
					0	0
West Wall	1-5/8" Vinyl Impact Resistant Acoustic Panels	1,800.00	1.16	1.16	2088	2088
East Wall	1-5/8" Vinyl Impact Resistant Acoustic Panels	1,800.00	1.16	1.16	2088	2088
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
Room Length (ft) :	203.00	ft	**$a = \sum S\alpha$**		29665.83	31783.67
Room Width (ft) :	121.00	ft				
Room Height (ft) :	33.33	ft	**$T_{60} = .05(V/\sum S\alpha)$**		**1.38**	**1.29**
Volume (ft^3) :	**818,685**	ft^3	CMU Reverberation Time		**1.39**	**1.32**

Target Reverberation Time: Gymnasium for Teaching*	1.5 to 1.8	1.5 to 1.8

* Target Reverberation Time obtained from the M^c Squared System Design Group, Inc.

Reverberation Time Calculator

$T_{60} = .05(V/a) = .05(V/\sum S\alpha)$

Reverberation Time Calculation for :		T.C. Williams High School Main Gymnasium					
Solarcrete System - w/ Fabrisorb™ Acoustic Wall Panels		Open Gym - 3/4 Occupancy King Street - Alexandria, VA					
			Absorption Coefficient		Sα		
Surface	**Material**	**Area (ft^2)**	**500 Hz**	**1000 Hz**	**500 Hz**	**1000 Hz**	
Floor	Athletic Wood Flooring	11,979.00	0.07	0.06	838.53	718.74	
Floor	3/4 Students, On Bleachers	9,438.00	0.49	0.84	4624.62	7927.92	
Floor	1/4 Wood Bleachers	3,146.00	0.22	0.39	692.12	1226.94	
Ceiling	3" Deep Acoustical Roof Deck	24,563.00	0.89	0.95	21861.07	23334.85	
North Wall	Concrete, Troweled	1,365.33	0.02	0.02	27.3066	27.3066	
North Wall	3/4 Students, On Bleachers	1,969.50	0.49	0.84	965.055	1654.38	
North Wall	1/4 Wood Bleachers	656.50	0.22	0.39	144.43	256.035	
North Wall	Metal Doors	42.00	0.10	0.10	4.2	4.2	
South Wall	Concrete, Troweled	1,323.33	0.02	0.02	26.4666	26.4666	
South Wall	3/4 Students, On Bleachers	1,969.50	0.49	0.84	965.055	1654.38	
South Wall	1/4 Wood Bleachers	656.50	0.22	0.39	144.43	256.035	
South Wall	Metal Doors	84.00	0.10	0.10	8.4	8.4	
West Wall	Concrete, Troweled	6,188.44	0.02	0.02	123.7688	123.7688	
West Wall	Metal Doors	168.00	0.10	0.10	16.8	16.8	
West Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56	
West Wall	Windows	122.22	0.18	0.12	21.9996	14.6664	
East Wall	Concrete, Troweled	5,978.44	0.02	0.02	119.5688	119.5688	
East Wall	Metal Doors	378.00	0.10	0.10	37.8	37.8	
East Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56	
East Wall	Windows	122.22	0.18	0.12	21.9996	14.6664	
					0	0	
West Wall	1-5/8" Vinyl Impact Resistant Acoustic Panels	1,800.00	1.16	1.16	2088	2088	
East Wall	1-5/8" Vinyl Impact Resistant Acoustic Panels	1,800.00	1.16	1.16	2088	2088	
					0	0	
					0	0	
Room Length (ft) :	203.00	ft	a = ∑Sα		35165.22	41956.04	
Room Width (ft) :	121.00	ft					
Room Height (ft) :	33.33	ft	$T_{60} = .05(V/\sum S\alpha)$		**1.16**	**0.98**	
Volume (ft^3) :	**818,685**	ft^3	CMU Reverberation Time		**1.16**	**1.00**	

Target Reverberation Time: Gymnasium for Teaching*	1.5 to 1.8	1.5 to 1.8

* Target Reverberation Time obtained from the M^c Squared System Design Group, Inc.

Reverberation Time Calculator

$T_{60} = .05(V/a) = .05(V/\sum S\alpha)$

Reverberation Time Calculation for :		**T.C. Williams High School Main Gymnasium**				
		Open Gym - Full Occupancy				
Solarcrete System - w/ Fabrisorb™ Acoustic Wall Panels		**King Street - Alexandria, VA**				
			Absorption Coefficient		**Sα**	
Surface	**Material**	**Area (ft^2)**	**500 Hz**	**1000 Hz**	**500 Hz**	**1000 Hz**
Floor	Athletic Wood Flooring	11,979.00	0.07	0.06	838.53	718.74
Floor	Students, On Bleachers	12,584.00	0.49	0.84	6166.16	10570.56
Ceiling	3" Deep Acoustical Roof Deck	24,563.00	0.89	0.95	21861.07	23334.85
North Wall	Concrete, Troweled	1,365.33	0.02	0.02	27.3066	27.3066
North Wall	Students, On Bleachers	2,626.00	0.49	0.84	1286.74	2205.84
North Wall	Metal Doors	42.00	0.10	0.10	4.2	4.2
South Wall	Concrete, Troweled	1,323.33	0.02	0.02	26.4666	26.4666
South Wall	Students, On Bleachers	2,626.00	0.49	0.84	1286.74	2205.84
South Wall	Metal Doors	84.00	0.10	0.10	8.4	8.4
West Wall	Concrete, Troweled	6,188.44	0.02	0.02	123.7688	123.7688
West Wall	Metal Doors	168.00	0.10	0.10	16.8	16.8
West Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
West Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
East Wall	Concrete, Troweled	5,978.44	0.02	0.02	119.5688	119.5688
East Wall	Metal Doors	378.00	0.10	0.10	37.8	37.8
East Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
East Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
					0	0
West Wall	1-5/8" Vinyl Impact Resistant Acoustic Panels	1,800.00	1.16	1.16	2088	2088
East Wall	1-5/8" Vinyl Impact Resistant Acoustic Panels	1,800.00	1.16	1.16	2088	2088
					0	0
					0	0
					0	0
					0	0
					0	0
Room Length (ft) :	203.00	ft	**$a = \sum S\alpha$**		36369.15	43962.59
Room Width (ft) :	121.00	ft				
Room Height (ft) :	33.33	ft	**$T_{60} = .05(V/\sum S\alpha)$**		**1.13**	**0.93**
Volume (ft^3) :	**818,685**	ft^3	CMU Reverberation Time		**1.13**	**0.95**

Target Reverberation Time: Gymnasium for Teaching*	1.5 to 1.8	1.5 to 1.8

* Target Reverberation Time obtained from the M[c] Squared System Design Group, Inc.

Reverberation Time Calculator

$T_{60} = .05(V/a) = .05(V/\sum S\alpha)$

Reverberation Time Calculation for :		T.C. Williams High School Main Gymnasium Open Gym - Bleachers Retracted				
Solarcrete System - w/ Fabrisorb™ Acoustic Wall Panels		King Street - Alexandria, VA				
			Absorption Coefficient		Sα	
Surface	Material	Area (ft^2)	500 Hz	1000 Hz	500 Hz	1000 Hz
Floor	Athletic Wood Flooring	24,563.00	0.07	0.06	1719.41	1473.78
Ceiling	3" Deep Acoustical Roof Deck	24,563.00	0.89	0.95	21861.07	23334.85
North Wall	Concrete, Troweled	1,365.33	0.02	0.02	27.3066	27.3066
North Wall	Wood Bleachers	2,626.00	0.22	0.39	577.72	1024.14
North Wall	Metal Doors	42.00	0.10	0.10	4.2	4.2
South Wall	Concrete, Troweled	1,323.33	0.02	0.02	26.4666	26.4666
South Wall	Wood Bleachers	2,626.00	0.22	0.39	577.72	1024.14
South Wall	Metal Doors	84.00	0.10	0.10	8.4	8.4
West Wall	Concrete, Troweled	6,188.44	0.02	0.02	123.7688	123.7688
West Wall	Metal Doors	168.00	0.10	0.10	16.8	16.8
West Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
West Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
East Wall	Concrete, Troweled	5,978.44	0.02	0.02	119.5688	119.5688
East Wall	Metal Doors	378.00	0.10	0.10	37.8	37.8
East Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
East Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
					0	0
West Wall	1-1/8" Fabric Impact Resistant Acoustic Panels	2,160.00	0.99	1.13	2138.4	2440.8
East Wall	1-1/8" Fabric Impact Resistant Acoustic Panels	2,160.00	0.99	1.13	2138.4	2440.8
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
Room Length (ft) :	203.00	ft	$a = \sum S\alpha$		29766.63	32489.27
Room Width (ft) :	121.00	ft				
Room Height (ft) :	33.33	ft	$T_{60} = .05(V/\sum S\alpha)$		1.38	1.26
Volume (ft^3) :	818,685	ft^3	CMU Reverberation Time		1.39	1.32

Target Reverberation Time: Gymnasium for Teaching*	1.5 to 1.8	1.5 to 1.8

* Target Reverberation Time obtained from the M[c] Squared System Design Group, Inc.

Reverberation Time Calculator

$T_{60} = .05(V/a) = .05(V/\sum S\alpha)$

Reverberation Time Calculation for :		T.C. Williams High School Main Gymnasium Open Gym - 3/4 Occupancy				
Solarcrete System - w/ Fabrisorb™ Acoustic Wall Panels		King Street - Alexandria, VA				
			Absorption Coefficient		Sα	
Surface	Material	Area (ft^2)	500 Hz	1000 Hz	500 Hz	1000 Hz
Floor	Athletic Wood Flooring	11,979.00	0.07	0.06	838.53	718.74
Floor	3/4 Students, On Bleachers	9,438.00	0.49	0.84	4624.62	7927.92
Floor	1/4 Wood Bleachers	3,146.00	0.22	0.39	692.12	1226.94
Ceiling	3" Deep Acoustical Roof Deck	24,563.00	0.89	0.95	21861.07	23334.85
North Wall	Concrete, Troweled	1,365.33	0.02	0.02	27.3066	27.3066
North Wall	3/4 Students, On Bleachers	1,969.50	0.49	0.84	965.055	1654.38
North Wall	1/4 Wood Bleachers	656.50	0.22	0.39	144.43	256.035
North Wall	Metal Doors	42.00	0.10	0.10	4.2	4.2
South Wall	Concrete, Troweled	1,323.33	0.02	0.02	26.4666	26.4666
South Wall	3/4 Students, On Bleachers	1,969.50	0.49	0.84	965.055	1654.38
South Wall	1/4 Wood Bleachers	656.50	0.22	0.39	144.43	256.035
South Wall	Metal Doors	84.00	0.10	0.10	8.4	8.4
West Wall	Concrete, Troweled	6,188.44	0.02	0.02	123.7688	123.7688
West Wall	Metal Doors	168.00	0.10	0.10	16.8	16.8
West Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
West Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
East Wall	Concrete, Troweled	5,978.44	0.02	0.02	119.5688	119.5688
East Wall	Metal Doors	378.00	0.10	0.10	37.8	37.8
East Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
East Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
					0	0
West Wall	1-1/8" Fabric Impact Resistant Acoustic Panels	2,160.00	0.99	1.13	2138.4	2440.8
East Wall	1-1/8" Fabric Impact Resistant Acoustic Panels	2,160.00	0.99	1.13	2138.4	2440.8
					0	0
					0	0
Room Length (ft) :	203.00	ft	$a = \sum S\alpha$		35266.02	42661.64
Room Width (ft) :	121.00	ft				
Room Height (ft) :	33.33	ft	$T_{60} = .05(V/\sum S\alpha)$		**1.16**	**0.96**
Volume (ft^3) :	**818,685**	ft^3	CMU Reverberation Time		**1.16**	**1.00**

Target Reverberation Time: Gymnasium for Teaching*	1.5 to 1.8	1.5 to 1.8

* Target Reverberation Time obtained from the M^c Squared System Design Group, Inc.

Reverberation Time Calculator

$T_{60} = .05(V/a) = .05(V/\sum S\alpha)$

Reverberation Time Calculation for :		T.C. Williams High School Main Gymnasium Open Gym - Full Occupancy				
Solarcrete System - w/ Fabrisorb™ Acoustic Wall Panels		King Street - Alexandria, VA				
			Absorption Coefficient		Sα	
Surface	Material	Area (ft^2)	500 Hz	1000 Hz	500 Hz	1000 Hz
Floor	Athletic Wood Flooring	11,979.00	0.07	0.06	838.53	718.74
Floor	Students, On Bleachers	12,584.00	0.49	0.84	6166.16	10570.56
Ceiling	3" Deep Acoustical Roof Deck	24,563.00	0.89	0.95	21861.07	23334.85
North Wall	Concrete, Troweled	1,365.33	0.02	0.02	27.3066	27.3066
North Wall	Students, On Bleachers	2,626.00	0.49	0.84	1286.74	2205.84
North Wall	Metal Doors	42.00	0.10	0.10	4.2	4.2
South Wall	Concrete, Troweled	1,323.33	0.02	0.02	26.4666	26.4666
South Wall	Students, On Bleachers	2,626.00	0.49	0.84	1286.74	2205.84
South Wall	Metal Doors	84.00	0.10	0.10	8.4	8.4
West Wall	Concrete, Troweled	6,188.44	0.02	0.02	123.7688	123.7688
West Wall	Metal Doors	168.00	0.10	0.10	16.8	16.8
West Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
West Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
East Wall	Concrete, Troweled	5,978.44	0.02	0.02	119.5688	119.5688
East Wall	Metal Doors	378.00	0.10	0.10	37.8	37.8
East Wall	AT-4 Wall Padding	288.00	0.60	0.62	172.8	178.56
East Wall	Windows	122.22	0.18	0.12	21.9996	14.6664
					0	0
West Wall	1-1/8" Fabric Impact Resistant Acoustic Panels	2,160.00	0.99	1.13	2138.4	2440.8
East Wall	1-1/8" Fabric Impact Resistant Acoustic Panels	2,160.00	0.99	1.13	2138.4	2440.8
					0	0
					0	0
					0	0
					0	0
					0	0
Room Length (ft) :	203.00	ft	$a = \sum S\alpha$		36469.95	44668.19
Room Width (ft) :	121.00	ft				
Room Height (ft) :	33.33	ft	$T_{60} = .05(V/\sum S\alpha)$		**1.12**	**0.92**
Volume (ft^3) :	**818,685**	ft^3	CMU Reverberation Time		**1.13**	**0.95**

Target Reverberation Time: Gymnasium for Teaching*	1.5 to 1.8	1.5 to 1.8

* Target Reverberation Time obtained from the M[c] Squared System Design Group, Inc.

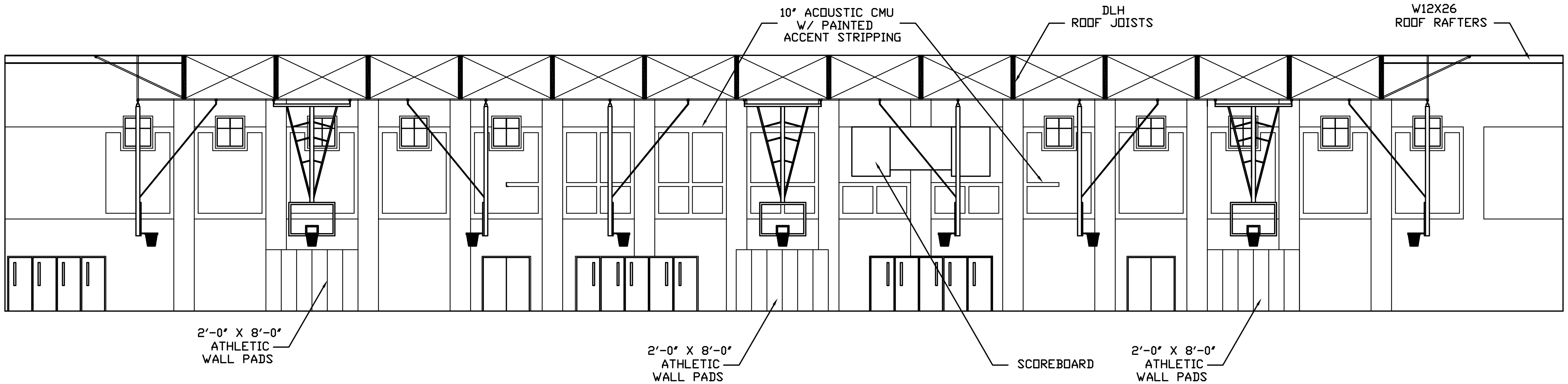
Appendix J

Area 5

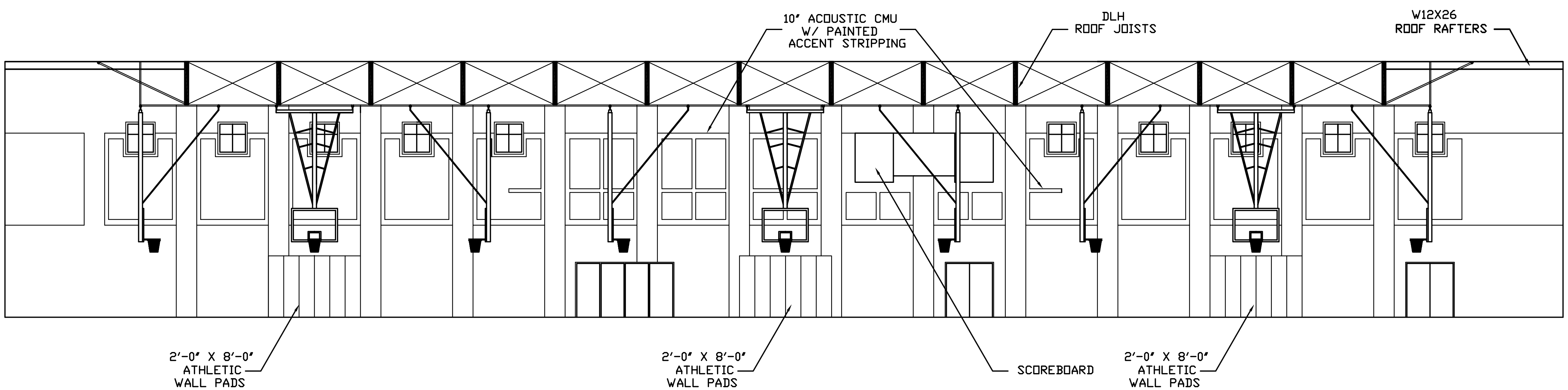
Gymnasium Elevations

T.C. Williams High School

Replacement Project



CURRENT DESIGN
MAIN GYMNASIUM
EAST ELEVATION



CURRENT DESIGN
MAIN GYMNASIUM
WEST ELEVATION

T.C. WILLIAMS HIGH SCHOOL REPLACEMENT PROJECT

OWNER:
ALEXANDRIA CITY PUBLIC SCHOOLS

LOCATION:
3330 KING STREET
ALEXANDRIA, VA 22302

MARK	DATE	DESCRIPTION
1	04/12/2007	FINAL REPORT

PROJECT NO:

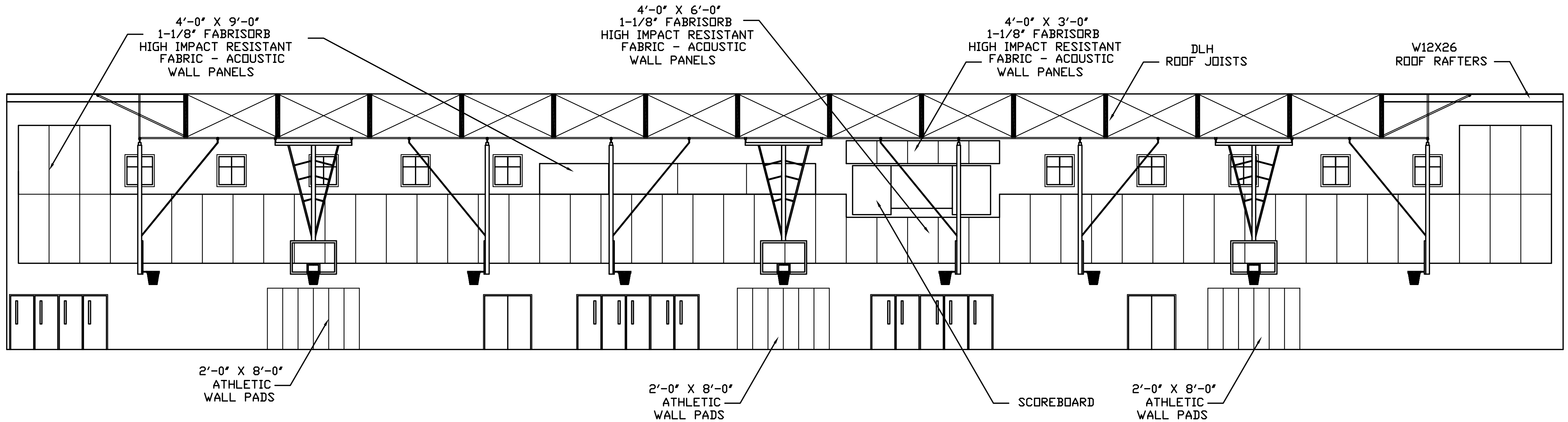
REVIEWED BY:

DRAWN BY: KYLE CONRAD

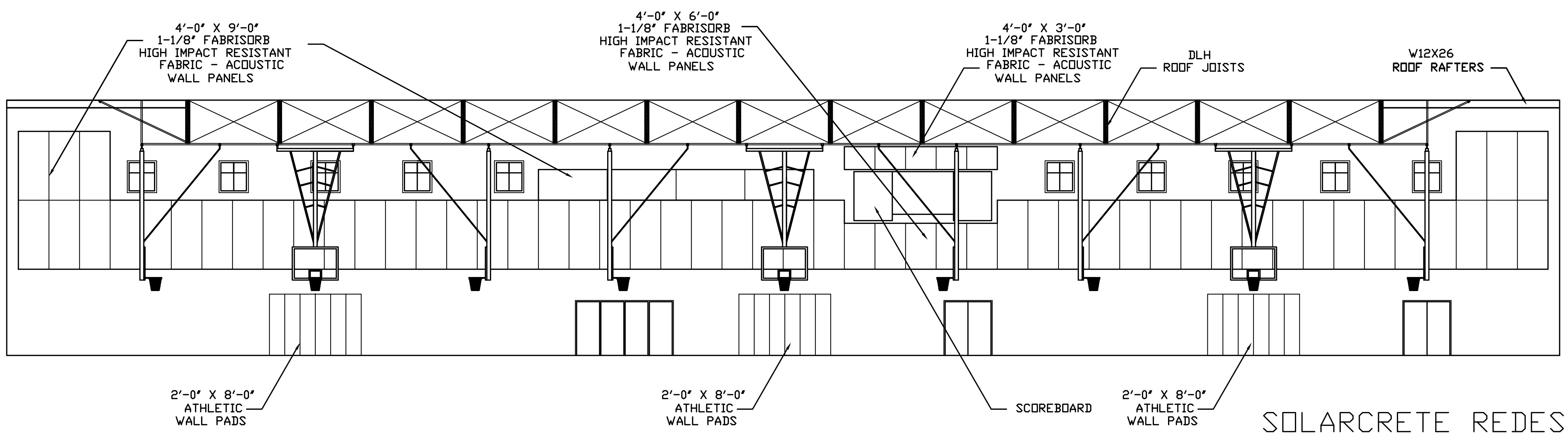
SCALE: 1/16" = 1'

SHEET TITLE:
GYMNASIUM ELEVATIONS

A-400



SOLARCRETE REDESIGN
W/ FABRISORB ACOUSTIC
WALL PANELS
MAIN GYMNASIUM
EAST ELEVATION



SOLARCRETE REDESIGN
W/ FABRISORB ACOUSTIC
WALL PANELS
MAIN GYMNASIUM
WEST ELEVATION

T.C. WILLIAMS HIGH SCHOOL REPLACEMENT PROJECT

OWNER:
ALEXANDRIA CITY PUBLIC SCHOOLS

LOCATION:
3330 KING STREET
ALEXANDRIA, VA 22302

MARK	DATE	DESCRIPTION
1	04/12/2007	FINAL REPORT

PROJECT NO.:

REVIEWED BY:

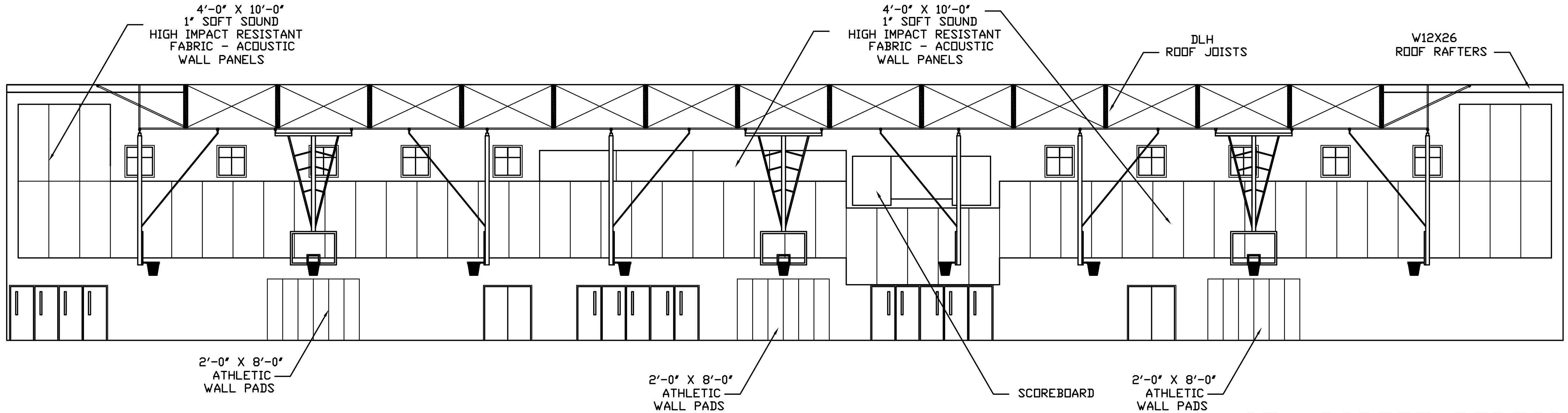
DRAWN BY: **KYLE CONRAD**

SCALE: 1/16" = 1'

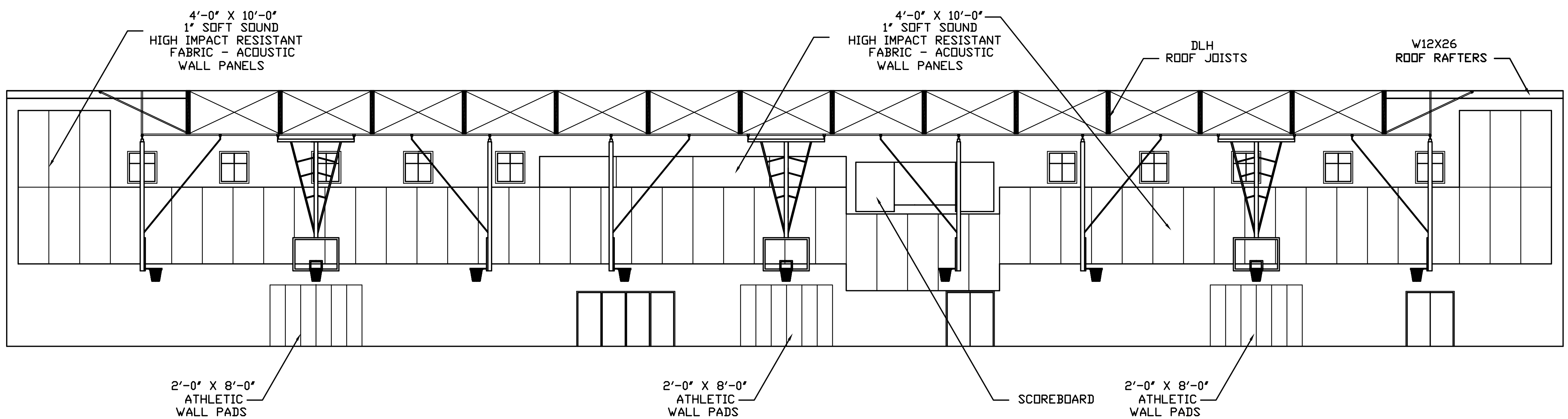
SHEET TITLE:

GYMNASIUM ELEVATIONS

A-401



SOLARCRETE REDESIGN
W/ SOFT SOUND ACOUSTIC
WALL PANELS
MAIN GYMNASIUM
EAST ELEVATION



SOLARCRETE REDESIGN
W/ SOFT SOUND ACOUSTIC
WALL PANELS
MAIN GYMNASIUM
WEST ELEVATION

T.C. WILLIAMS
HIGH SCHOOL
REPLACEMENT
PROJECT

OWNER:
ALEXANDRIA CITY
PUBLIC SCHOOLS

LOCATION:
3330 KING STREET
ALEXANDRIA, VA 22302

MARK	DATE	DESCRIPTION
1	04/12/2007	FINAL REPORT

PROJECT NO:
REVIEWED BY:
DRAWN BY: **KYLE CONRAD**
SCALE: 1/16" = 1'
SHEET TITLE:

GYMNASIUM
ELEVATIONS

A-402

Appendix K

Acoustical Surfaces, Inc.

Fabrisorb™ Acoustic Wall Panel Data

T.C. Williams High School

Replacement Project

Acoustical Surfaces, Inc.
We identify and
S.T.O.P
Your Noise Problems
Sound Transmission Obscuring Products
Soundproofing, Acoustics, Noise & Vibration Control Specialists ™

Acoustical Surfaces, Inc.

SOUNDPROOFING, ACOUSTICS, NOISE & VIBRATION CONTROL SPECIALISTS

123 Columbia Court North • Suite 201 • Chaska, MN 55318
(952) 448-5300 • Fax (952) 448-2613 • (800) 448-0121

Email: sales@acousticalsurfaces.com
Visit our Website: www.acousticalsurfaces.com

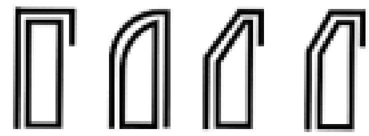
We Identify and S.T.O.P. Your Noise Problems

FABRIC PANEL S.T.O.P.™

Decorative Fabric Wrapped Custom Acoustical Wall Panels

- ***High Performance***
- ***Architecturally Decorative***
- ***Custom Engineered & Manufactured***
- ***Reduced Noise & Reverberation***

EDGE DETAILS



MATERIAL: 6 lb. density glass fiber with woven fabric and microperforated vinyl facings.

PATTERN: Flat faced with square or radiused corners, beveled, radiused or mitered edges.

FEATURES: Custom designed and manufactured to meet every need. Flat or curved panels. Soft or hard edges

APPLICATIONS: Offices, schools, meeting rooms, music rooms, hotels, auditoriums, recording studios, broadcasting studios. Any space where good speech privacy or speech intelligibility is important.

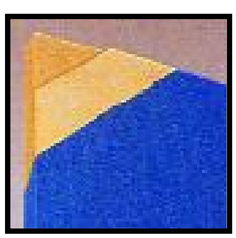
THICKNESS: 1", 1-1/8", 2", 2-1/8" **SIZES:** 2' x 4' and a wide range of custom sizes.

COLOR: A wide range of standard colors for woven fabrics and perforated vinyls.

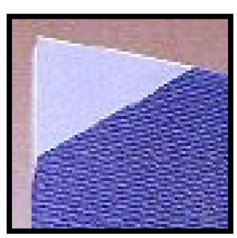
FLAMMABILITY: ASTM E-84, Class A. Flame Spread: 15, Smoke Developed: 40.

INSTALLATION: Adhesive, hook & loop fasteners, mechanical clips, impaling clips, magnetic clips, splines.

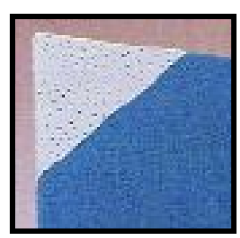
ABSORPTIVE
High performance absorption.



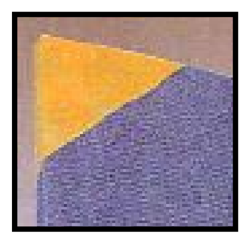
HIGH IMPACT
Absorptive in high traffic areas.



REFLECTIVE
For combined use in studios for absorption and reflection.

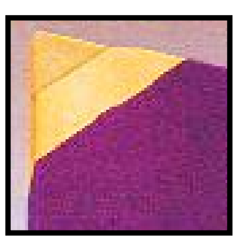


MINERAL CORE
multi-purpose panel for absorption and sound blocking.

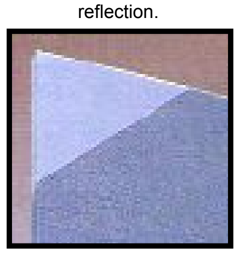


ABUSE RESISTANT
For gymnasiums, absorption and abuse resistance.

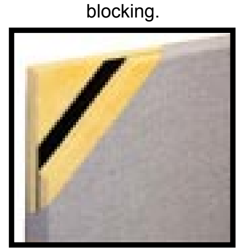
TACKABLE 1
For long lasting and effective tackability.



HI-TACK
High absorption and tackability.



TACKABILITY 2
Tackability where sound absorption is not necessary.



NOISE BARRIER
Barricade vinyl barrier, ideal for areas requiring high STC.

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NOISE S.T.O.P. Fabrisorb™
Decorative Fabric Wrapped, Custom Acoustical Wall Panels, 4 Edge Details

Noise S.T.O.P. Fabrisorb™. acoustical panels are generally fabricated using a decorative woven fabric or perforated vinyl over an acoustically absorptive fiberglass core material. The thickness of the absorptive core material is the overriding element that will affect the panel's acoustical performance. Since the fiberglass core is manufactured by relatively few companies such as, Owens Coming, Johns Manville, CertainTeed, Knauf and a few others the acoustical performance should not vary significantly. When comparing one manufacturer to another, it is important to ascertain that the test protocol is the same for a particular application. The densities of the fiberglass used in the manufacture of acoustical wall panels generally will be in the realm of 6 lbs per cubic foot.

Since the various acoustical wall panel manufacturers all purchase their acoustical core materials from the same sources it is highly unlikely that the acoustical performance will vary from one acoustical panel manufacturer to another on a consistent basis. Likewise the decorative fabric coverings are also procured from the same source and thus the performance should be the same or similar.

Acoustical wall panels are used principally for the purpose of reducing the Reverberation Time in a space to make speech more intelligible.

There are a number of applications that can affect the acoustical performance of the panels, using a 2" thickness will improve the overall NRC performance however the performance difference at the voice frequency rang of 500 Hz is only in the order of about 8%, therefore it makes no sense to spend 40% in order to gain an 8% improvement. 2" thick acoustical wall panels do provide better acoustical performance at the lower frequencies so if low frequency noise is the problem the thicker panels are appropriate.

Mounting the panels on furring strips will improve the acoustical performance and may be a practical and cost effective feature. In addition using soft edged panels separated by space between the applied panels will also improve the acoustical performance though the "edge effect" and "diffraction".

Most acoustical panels specified by architects employ edge hardening which is not necessary in this day and age with the improvements that have been made in the manufacture of fiberglass core materials. So when comparing acoustical test data be sure to compare the material and test application carefully to determine if you are comparing apples with apples.

The following test results are a typical compilation for various acoustical panels and where conducted at an independent acoustical test laboratory by and under the direction of the author Mike Nixon at Acoustical Surfaces Inc.

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TECHNICAL DATA

ACOUSTICAL TESTS – NOISE S.T.O.P. FABRISORB™ WALL PANELS

Material Thickness/Core Facing	Mounting	Absorption Coefficient Octave Band Center Frequency Hz						
		125	250	500	1000	2000	4000	NRC
3/4" fiberglass-fabric	A-Mod	0.10	0.19	0.57	0.97	1.10	1.02	**0.70**
3/4" fiberglass-perf. vinyl	A-Mod	0.10	0.44	0.56	0.97	0.90	0.71	**0.70**
1" fiberglass-fabric	A	0.06	0.24	0.71	1.10	1.15	1.02	**0.80**
1" fiberglass-fabric	A-Mod	0.21	0.41	0.93	1.15	1.00	0.95	**0.85**
1" fiberglass-fabric-perforated vinyl	A	0.08	0.33	0.84	1.04	1.01	0.77	**0.80**
1" fiberglass-fabric-perforated vinyl	A-Mod	0.14	0.51	0.90	1.04	0.95	0.90	**0.85**
1-1/8" H.I.R. fiberglass-fabric	A	0.09	0.50	0.99	1.13	1.08	0.96	**0.95**
1-1/8" H.I.R. F/G-perf. vinyl	A-Mod	0.14	0.51	0.90	1.04	0.95	0.90	**0.85**
1-1/2" fiberglass-fabric	A	0.24	0.72	1.10	1.15	1.13	1.08	**1.05**
1-5/8" H.I.R. F/G-perf	A-Mod	0.23	0.64	1.16	1.16	1.14	1.02	**1.05**
2" fiberglass-fabric	A-Mod	0.33	0.71	1.23	1.29	1.22	1.24	**1.10**
2-1/8" H.I.R. F/G-fabric	A-Mod	0.45	0.91	1.09	1.14	1.02	0.98	**1.05**
2" L.F.T. fiberglass-fabric	A-Mod	0.67	0.62	0.56	0.39	0.33	0.14	**0.50**
2" ACOUSTI-SAN wall panel	A	0.27	0.68	0.97	0.95	0.85	0.69	**0.85**
1/2" Mineral Board-fabric	A	0.05	0.18	0.49	0.63	0.71	0.76	**0.50**
3/4" Mineral Board-fabric	A	0.10	0.26	0.56	0.81	0.93	0.77	**0.65**
1-1/16" S.H.I.R. F/G-fabric	A-Mod	0.12	0.39	0.91	1.03	0.99	0.99	**0.85**
2-1/16" S.H.I.R. F/G-fabric	A-Mod	0.33	0.71	1.23	1.29	1.22	1.24	**1.10**

NOTE:
1. All fiberglass (F/G) core tested was 6-7 p.c.f.
2. Fabric facing tested was 100% woven polyester.
3. Perforated vinyl facing tested was GenCorp Web Core vinyl.
4. H.I.R. refers to High Impact Resistance face, 18-20 p.c.f. fiberglass over core.
5. Mounting referred to as Mod. (modified) is a test with 3/16" air space between panel and substrate to simulate mechanical mounting.
6. All testing conducted by certified NVLAP independent testing laboratory in accordance with ASTM C-423 – “Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method”.

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TECHNICAL DATA

ACOUSTICAL TESTS – NOISE S.T.O.P. FABRISORB™ CEILING PANELS & CLOUDS

Material	Mounting	Absorption Coefficient						
Thickness/Core Facing		Octave Band Center Frequency Hz						
		125	250	500	1000	2000	4000	NRC
1" ACOUSTI-SAN Ceiling Tile	E	0.65	0.83	0.91	0.98	1.02	1.74	**0.95**
1" Nubby Ceiling Tile	E	0.69	0.95	0.85	1.06	1.11	1.08	**0.95**
1-1/2" Nubby Ceiling Tile	E	0.67	0.95	0.97	1.13	1.15	1.08	**1.05**
3/4" Painted Mat-Euromat	E	0.69	0.62	0.61	0.89	1.91	0.79	**0.75**
1" Painted Mat-Euromat	E	0.56	0.93	0.96	1.01	1.12	1.20	**1.00**
2" Painted Mat-Euromat	E	0.50	0.92	0.99	1.09	1.15	1.19	**1.05**
1/2" F/G - 1/2" Min. Board-Fabric	E	0.40	0.44	0.62	0.86	0.92	1.02	**0.70**
1" F/G - 1/2" Min. Board-Fabric	E	0.48	0.65	1.00	1.05	1.10	1.15	**0.95**
1" F/G - Fabric - Ceiling Cloud	E	0.56	0.93	0.96	1.01	1.12	1.20	**1.00**
2" F/G - Fabric - Ceiling Cloud	E	0.50	0.92	0.99	1.09	1.15	1.19	**1.05**

NOTE:
1. All fiberglass (F/G) core tested was 6-7 p.c.f.
2. Fabric facing tested was 100% woven polyester.
3. Perforated vinyl facing tested was GenCorp Web Core vinyl.
4. All testing conducted by certified NVLAP independent testing laboratory in accordance with ASTM C-423 – "Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method".

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TECHNICAL DATA

ACOUSTICAL TESTS – NOISE S.T.O.P. FABRISORB™ SUSPENDED CEILING BAFFLES

Material Thickness/Core Facing	Mounting	Absorption Coefficient Octave Band Center Frequency Hz						
		125	250	500	1000	2000	4000	**NRC**
2" F/G Baffle-Fabric	H	2.8	6.5	12.3	15.2	15.2	15.7	**12.3**
2" ACOUSTI-SAN Baffle	H	2.7	6.2	12.1	14.9	15.1	15.3	**12.0**
Rectangular Prism- 12"x12"x48"	H	5.6	11.0	13.8	17.5	16.1	12.2	**14.6**
Triangular Prism- 12"x12"x48"	H	4.4	10.6	15.2	17.6	15.9	12.0	**14.8**
Cylinder Prism- 9" Long x 36" Long	H	2.0	4.2	6.4	7.0	7.8	5.4	**6.3**

TECHNICAL DATA

ACOUSTICAL TESTS – DIFFUSERS-ABSORBERS

Material Thickness/Core Facing	Mounting	Absorption Coefficient Octave Band Center Frequency Hz						
		125	250	500	1000	2000	4000	**NRC**
Barrel Diffuser-Paint Finish	A	0.20	0.22	0.10	0.05	0.04	0.07	**0.10**
Barrel Diffuser-Fabric Finish	A	0.18	0.27	0.18	0.14	0.19	0.15	**0.20**
Pyramid Diffuser-Paint Finish	A	0.20	0.22	0.10	0.05	0.04	0.07	**0.10**
2" F/G-Absorber-Fabric Finish	A-Mold	0.33	0.71	1.23	1.29	1.22	1.24	**1.10**

NOTE:
1. All fiberglass (F/G) core tested was 6-7 p.c.f.
2. Fabric facing tested was 100% woven polyester.
3. Perforated vinyl facing tested was GenCorp Web Core vinyl.
4. All testing conducted by certified NVLAP independent testing laboratory in accordance with ASTM C-423 – "Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method".

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QUOTATION ACKNOWLEDGEMENT

This is acknowledgement of a quotation you have requested from Acoustical Surfaces Inc. (ASI) Please verify quantities, description, price and shipping information. Notify us immediately if incorrect. All changes must be confirmed in writing. All Shipments are FOB plant and shipped freight added, collect or 3rd party billed if requested. Custom and prefinished orders require a deposit. Custom, prefinished and fire retardant products are not returnable. All orders are contingent upon approved credit and acceptance. Prices do not include taxes, duty or custom crating and cartoning. All returns are subject to as much as a 50% restocking fee.

Thank You For The Opportunity To Quote **Quote #:** 13458

Quoted to: Penn Sate University Architectural Engineers Contact: Kyle Conrad
Address: 1618 Plaza Drive, State College, PA 16801
Phone: 814-937-6332 Fax: Email: kac357@psu.edu
Job Name & Shipping Location: Penn State Arch. Engineering
When Required: 5/11/2007 Valid Through: 8/9/2007 Approx. Escalation: Varies
Comments:

BEST PRICE GUARANTEE

We appreciate your business and we will do what it takes to earn it. If you did not buy from ASI, you probably paid too much! The more you buy the more you save, volume discounts available. Our goal is to offer the highest quality materials and service at the most competitive price. If you find any competitors identical product at a lower price than ours, please contact your salesperson prior to purchase. We will review your quote and attempt to verify and beat any bona fide price. Quotation adjustments must be made prior to purchase and require written confirmation.

Quantity	Unit	Item No.	Description	Unit Price	Extension
3600	PSF	FWP-HI-11/8	1 1/8" Thickness High Impact Fabric Wrapped Panels constructed with standard 6-7lb density fiberglass core faced with 1/8" thick, compressed fiberglass layer for impact resistance. Panels will have square resin	$7.59	$27,324.00
			hardened edges and Guilford FR 701 (Style 2100) Fabric Facing. Color: To Be Determined. 100 (4' wide x 9' tall) Panels Total		
1000	Each	Impaling Clips	Impaling Clips for direct wall mounting - To be used with PSA-29 Acoustical Panel Adhesive.	$0.50	$500.00
120	Tube	PSA-29	PSA-29 Acoustical Panel Adhesive for direct surface mounting acoustical panels to a substrate. Approximately 32 square feet of panels per 29oz. Tube. 120 (29 Ounce) Tubes total	$9.25	$1,110.00
2	Each	Packing Fee	Packing / Plywood Crating fee for safe delivery of panels	$125.00	$250.00
		Shipping	Loading dock to non-commercial delivery location arriving on a truck with a lift gate.		

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Quantity	Unit	Item No.	Description	Unit Price	Extension

☐ Sample ☐ Catalog ☐ Drawing ☐ Specifications

Approx Lead Time: 1 to 2 Weeks

Terms: *With Approved Credit* Prepay

Deposit Required: $31,028.60

Subtotal:	$29,184.00
Shipping/Handling:	$1,844.60
Sales Tax:	
Total:	$31,028.60
Quote Date:	5/11/2007
Quoted By:	Ted Weidman

Major Credit Cards Accepted:

DISCOVER NOVUS | VISA | MasterCard | AMERICAN EXPRESS Card

APPENDIX L

Areas 5, 6, & 7

CMU Wall Schedule

T.C. Williams High School

Replacement Project

CMU Wall Schedule

Type	Mark	Area (ft^2)	Length	Width	Volume (ft^3)
10" Masonry	Gymnasium	28	2' - 7 5/8"	0' - 9 5/8"	22.55
10" Masonry	Gymnasium	145	9' - 5 11/32"	0' - 9 5/8"	116.17
10" Masonry	Gymnasium	40	2' - 7 5/8"	0' - 9 5/8"	32.41
10" Masonry	Gymnasium	49	2' - 7 5/8"	0' - 9 5/8"	38.96
10" Masonry	Gymnasium	124	8' - 9 5/8"	0' - 9 5/8"	99.41
8" Masonry	Gymnasium	240	14' - 4 3/8"	0' - 7 5/8"	152.50
10" Masonry	Mech/Elec Wedge - Auto Strip	2,444	121' - 8"	0' - 9 5/8"	1,960.43
10" Masonry	Mech/Elec Wedge - Auto Strip	51	3' - 4"	0' - 9 5/8"	41.00
10" Masonry	Mech/Elec Wedge - Auto Strip	215	14' - 10 5/8"	0' - 9 5/8"	172.18
10" Masonry	Mech/Elec Wedge - Auto Strip	51	3' - 4"	0' - 9 5/8"	41.00
10" Masonry	Mech/Elec Wedge - Auto Strip	2,929	145' - 4 9/32"	0' - 9 5/8"	2,344.65
10" Masonry	Mech/Elec Wedge - Auto Strip	423	20' - 11 5/16"	0' - 9 5/8"	334.44
10" Masonry	Mech/Elec Wedge - Auto Strip	491	25' - 4 3/8"	0' - 9 5/8"	393.52
10" Masonry	Mech/Elec Wedge - Auto Strip	876	43' - 9 5/8"	0' - 9 5/8"	702.66
10" Masonry	Mech/Elec Wedge - Auto Strip	1,158	57' - 11"	0' - 9 5/8"	929.08
10" Masonry	Mech/Elec Wedge - Auto Strip	582	28' - 6 3/8"	0' - 9 5/8"	467.12
10" Masonry	Auditorium	51	4' - 0"	0' - 9 5/8"	41.04
10" Masonry	Auditorium	142	9' - 0"	0' - 9 5/8"	114.03
10" Masonry	Auditorium	64	4' - 0"	0' - 9 5/8"	51.33
10" Masonry	Auditorium	757	38' - 1"	0' - 9 5/8"	607.49
10" Masonry	Auditorium	147	7' - 4"	0' - 9 5/8"	117.64
10" Masonry	Auditorium	803	39' - 7"	0' - 9 5/8"	644.42
10" Masonry	Auditorium	48	4' - 0"	0' - 9 5/8"	38.50
10" Masonry	Auditorium	98	8' - 2 1/8"	0' - 9 5/8"	78.70
10" Masonry	Auditorium	38	4' - 0"	0' - 9 5/8"	30.78
10" Masonry	Auditorium	721	35' - 8 1/4"	0' - 9 5/8"	578.49
10" Masonry	Auditorium	65	4' - 5 3/16"	0' - 9 5/8"	51.73
10" Masonry	Auditorium	131	8' - 2 1/8"	0' - 9 5/8"	104.94
10" Masonry	Auditorium	51	4' - 0"	0' - 9 5/8"	41.04
10" Masonry	Auditorium	652	32' - 9 7/8"	0' - 9 5/8"	523.10
10" Masonry	Auditorium	96	8' - 0"	0' - 9 5/8"	77.00
10" Masonry	Auditorium	110	10' - 0 5/8"	0' - 9 5/8"	88.23
10" Masonry	Auditorium	96	8' - 0"	0' - 9 5/8"	77.00
10" Masonry	Gymnasium	148	7' - 4 5/8"	0' - 9 5/8"	118.47
10" Masonry	Gymnasium	205	10' - 1 17/32"	0' - 9 5/8"	162.67
10" Masonry	Gymnasium	193	9' - 7 15/16"	0' - 9 5/8"	155.00
10" Masonry	Gymnasium	153	8' - 5 11/16"	0' - 9 5/8"	122.62
10" Masonry	Gymnasium	1,543	76' - 4 19/32"	0' - 9 5/8"	1,237.26
10" Masonry	Gymnasium	872	26' - 8 3/8"	0' - 9 5/8"	699.52
10" Masonry	Gymnasium	449	13' - 4"	0' - 9 5/8"	360.50
10" Masonry	Gymnasium	140	8' - 8 13/16"	0' - 9 5/8"	112.35
10" Masonry	Gymnasium	339	12' - 0"	0' - 9 5/8"	271.63
10" Masonry	Gymnasium	136	9' - 9"	0' - 9 5/8"	109.02
10" Masonry	Gymnasium	43	2' - 0"	0' - 9 5/8"	34.46
10" Masonry	Gymnasium	123	8' - 9 5/8"	0' - 9 5/8"	98.39
10" Masonry	Gymnasium	43	2' - 0"	0' - 9 5/8"	34.46
10" Masonry	Gymnasium	851	55' - 6 3/8"	0' - 9 5/8"	682.96

CMU Wall Schedule					
Type	Mark	Area (ft^2)	Length	Width	Volume (ft^3)
10" Masonry	Gymnasium	118	7' - 8"	0' - 9 5/8"	94.29
10" Masonry	Gymnasium	118	7' - 8"	0' - 9 5/8"	94.29
10" Masonry	Gymnasium	118	7' - 8"	0' - 9 5/8"	94.29
10" Masonry	Gymnasium	190	12' - 0 1/8"	0' - 9 5/8"	152.66
8" Masonry	Gymnasium	886	55' - 8 3/16"	0' - 7 5/8"	562.87
10" Masonry	Gymnasium	940	59' - 1"	0' - 9 5/8"	754.17
10" Masonry	Gymnasium	799	49' - 11 3/8"	0' - 9 5/8"	641.00
10" Masonry	Gymnasium	629	31' - 5 3/8"	0' - 9 5/8"	504.48
8" Masonry	Gymnasium	907	31' - 5 3/8"	0' - 7 5/8"	576.23
10" Masonry	Gymnasium	2,103	74' - 1"	0' - 9 5/8"	1,686.88
10" Masonry	Gymnasium	5,901	205' - 5 3/16"	0' - 9 5/8"	4,732.74
8" Masonry	Gymnasium	3,322	207' - 4"	0' - 7 5/8"	2,111.12
10" Masonry	Gymnasium	1,008	63' - 0"	0' - 9 5/8"	808.50
8" Masonry	Gymnasium	860	54' - 5 3/8"	0' - 7 5/8"	546.25
8" Masonry	Gymnasium	820	51' - 6 13/16"	0' - 7 5/8"	521.04
8" Masonry	Mech/Elec Wedge - Auto Strip	937	59' - 4"	0' - 7 5/8"	595.07
10" Masonry	Auditorium	579	28' - 9 9/32"	0' - 9 5/8"	460.14
12" Masonry	Gymnasium	127	3' - 11 3/16"	0' - 11 5/8"	122.65
6" Masonry	Gymnasium	128	4' - 10 3/16"	0' - 5 5/8"	59.77
6" Masonry	Gymnasium	158	10' - 9"	0' - 5 5/8"	73.98
10" Masonry	Gymnasium	420	13' - 9"	0' - 9 5/8"	337.07
8" Masonry	Gymnasium	977	61' - 9"	0' - 7 5/8"	620.48
10" Masonry	Gymnasium	305	15' - 6 19/32"	0' - 9 5/8"	242.79
10" Masonry	Gymnasium	157	9' - 6 13/16"	0' - 9 5/8"	125.79
14" Masonry	Gymnasium	7,411	205' - 10 3/8"	1' - 1 5/8"	8,414.71
10" Masonry	Gymnasium	6,686	203' - 10 3/8"	0' - 9 5/8"	5,362.55
10" Masonry	Gymnasium	3,955	121' - 10 3/8"	0' - 9 5/8"	3,172.01
14" Masonry	Gymnasium	4,459	123' - 9 3/8"	1' - 1 5/8"	5,062.96
12" Masonry	Gymnasium	7,411	205' - 10 3/8"	0' - 11 5/8"	7,179.53
10" Masonry	Gymnasium	6,660	203' - 10 3/8"	0' - 9 5/8"	5,341.54
12" Masonry	Gymnasium	2,667	92' - 11 3/8"	0' - 11 5/8"	2,583.56
12" Masonry	Gymnasium	1,664	59' - 0"	0' - 11 5/8"	1,611.58
8" Masonry	Gymnasium	49	1' - 10 3/8"	0' - 7 5/8"	30.93
8" Masonry	Gymnasium	202	7' - 10"	0' - 7 5/8"	128.08
8" Masonry	Gymnasium	49	1' - 10 3/8"	0' - 7 5/8"	30.93
8" Masonry	Gymnasium	215	8' - 3 5/8"	0' - 7 5/8"	136.61
10" Masonry	Gymnasium	63	1' - 8 5/16"	0' - 9 5/8"	48.43
10" Masonry	Gymnasium	1,726	60' - 6 29/32"	0' - 9 5/8"	1,383.25
10" Masonry	Mech/Elec Wedge - Auto Strip	4,293	268' - 4"	0' - 9 5/8"	3,443.61
8" Masonry	Mech/Elec Wedge - Auto Strip	1,004	63' - 6 3/8"	0' - 7 5/8"	637.75
8" Masonry	Mech/Elec Wedge - Auto Strip	1,239	62' - 8"	0' - 7 5/8"	787.22
10" Masonry	Mech/Elec Wedge - Auto Strip	77	4' - 9 3/4"	0' - 9 5/8"	61.77
8" Masonry	Mech/Elec Wedge - Auto Strip	990	62' - 8"	0' - 7 5/8"	628.96
6" Masonry	Mech/Elec Wedge - Auto Strip	48	3' - 2"	0' - 5 5/8"	22.50
6" Masonry	Mech/Elec Wedge - Auto Strip	118	7' - 4 3/8"	0' - 5 5/8"	55.23
6" Masonry	Mech/Elec Wedge - Auto Strip	41	3' - 2"	0' - 5 5/8"	18.98
6" Masonry	Mech/Elec Wedge - Auto Strip	27	1' - 10"	0' - 5 5/8"	12.50

CMU Wall Schedule					
Type	Mark	Area (ft^2)	Length	Width	Volume (ft^3)
6" Masonry	Mech/Elec Wedge - Auto Strip	118	7' - 4 3/8"	0' - 5 5/8"	55.23
6" Masonry	Mech/Elec Wedge - Auto Strip	19	1' - 10"	0' - 5 5/8"	8.98
8" Masonry	Gymnasium	688	43' - 3 13/16"	0' - 7 5/8"	437.17
10" Masonry	Gymnasium	670	41' - 10 1/4"	0' - 9 5/8"	537.13
8" Masonry	Gymnasium	625	39' - 0 5/8"	0' - 7 5/8"	397.03
12" Masonry	Auditorium	93	13' - 6 17/32"	0' - 11 5/8"	90.48
10" Masonry	Auditorium	437	20' - 3 3/32"	0' - 9 5/8"	350.37
6" Masonry	Auditorium	1,805	112' - 11 3/8"	0' - 5 5/8"	845.86
12" Masonry	Auditorium	3,635	111' - 3 3/8"	0' - 11 5/8"	3,521.59
14" Masonry	Auditorium	4,489	136' - 8 13/32"	1' - 1 5/8"	5,083.02
6" Masonry	Auditorium	2,147	134' - 10 7/16"	0' - 5 5/8"	1,005.45
8" Masonry	Auditorium	1,374	85' - 10 7/32"	0' - 7 5/8"	872.82
8" Masonry	Auditorium	283	17' - 10"	0' - 7 5/8"	179.61
8" Masonry	Auditorium	457	29' - 2"	0' - 7 5/8"	290.07
8" Masonry	Auditorium	457	29' - 2"	0' - 7 5/8"	290.07
8" Masonry	Auditorium	326	20' - 9 3/16"	0' - 7 5/8"	207.04
8" Masonry	Auditorium	285	17' - 8"	0' - 7 5/8"	181.31
10" Masonry	Auditorium	832	29' - 7 3/16"	0' - 9 5/8"	667.52
10" Masonry	Auditorium	971	72' - 6 13/16"	0' - 9 5/8"	775.45
14" Masonry	Auditorium	260	9' - 0 1/32"	1' - 1 5/8"	293.05
6" Masonry	Auditorium	1,295	45' - 8 3/4"	0' - 5 5/8"	606.86
14" Masonry	Auditorium	55	3' - 11"	1' - 1 5/8"	54.73
14" Masonry	Auditorium	1,872	41' - 6 7/32"	1' - 1 5/8"	2,125.96
6" Masonry	Auditorium	1,374	86' - 1 13/32"	0' - 5 5/8"	644.12
14" Masonry	Auditorium	1,130	39' - 11 23/32"	1' - 1 5/8"	1,282.71
10" Masonry	Mech/Elec Wedge - Auto Strip	1,218	76' - 6 15/32"	0' - 9 5/8"	970.18
10" Masonry	Mech/Elec Wedge - Auto Strip	259	16' - 2"	0' - 9 5/8"	207.47
10" Masonry	Mech/Elec Wedge - Auto Strip	339	21' - 2"	0' - 9 5/8"	271.64
10" Masonry	Mech/Elec Wedge - Auto Strip	141	8' - 10"	0' - 9 5/8"	113.36
10" Masonry	Mech/Elec Wedge - Auto Strip	123	7' - 8"	0' - 9 5/8"	98.39
10" Masonry	Mech/Elec Wedge - Auto Strip	848	53' - 0"	0' - 9 5/8"	680.17
12" Masonry	Auditorium	464	14' - 11 3/32"	0' - 11 5/8"	442.29
12" Masonry	Auditorium	429	28' - 8 23/32"	0' - 11 5/8"	411.80
12" Masonry	Auditorium	38	5' - 3 5/32"	0' - 11 5/8"	36.23
10" Masonry	Auditorium	129	8' - 3 3/8"	0' - 9 5/8"	103.12
8" Masonry	Auditorium	841	36' - 9 7/8"	0' - 7 5/8"	524.29
8" Masonry	Auditorium	194	8' - 4 23/32"	0' - 7 5/8"	121.21
8" Masonry	Auditorium	127	5' - 8 31/32"	0' - 7 5/8"	72.90
8" Masonry	Auditorium	227	10' - 6 3/8"	0' - 7 5/8"	142.81
8" Masonry	Auditorium	66	2' - 11"	0' - 7 5/8"	42.01
8" Masonry	Auditorium	173	8' - 3 3/8"	0' - 7 5/8"	109.65
8" Masonry	Auditorium	234	10' - 6 1/2"	0' - 7 5/8"	147.65
10" Masonry	Auditorium	82	3' - 8 3/8"	0' - 9 5/8"	66.09
10" Masonry	Auditorium	149	6' - 4 3/8"	0' - 9 5/8"	119.11
10" Masonry	Auditorium	64	3' - 8 3/8"	0' - 9 5/8"	51.08
8" Masonry	Auditorium	132	5' - 8"	0' - 7 5/8"	84.02
10" Masonry	Auditorium	702	30' - 7 9/16"	0' - 9 5/8"	562.60

CMU Wall Schedule					
Type	Mark	Area (ft^2)	Length	Width	Volume (ft^3)
8" Masonry	Auditorium	89	4' - 0 25/32"	0' - 7 5/8"	55.45
8" Masonry	Auditorium	841	36' - 9 7/8"	0' - 7 5/8"	524.29
8" Masonry	Auditorium	194	8' - 4 23/32"	0' - 7 5/8"	121.21
8" Masonry	Auditorium	127	5' - 8 31/32"	0' - 7 5/8"	72.90
8" Masonry	Auditorium	227	10' - 6 3/8"	0' - 7 5/8"	142.81
8" Masonry	Auditorium	323	14' - 5 5/8"	0' - 7 5/8"	205.10
8" Masonry	Auditorium	234	10' - 6 1/2"	0' - 7 5/8"	147.65
10" Masonry	Auditorium	82	3' - 8 3/8"	0' - 9 5/8"	66.09
10" Masonry	Auditorium	149	6' - 4 3/8"	0' - 9 5/8"	119.11
10" Masonry	Auditorium	64	3' - 8 3/8"	0' - 9 5/8"	51.08
8" Masonry	Auditorium	132	5' - 8"	0' - 7 5/8"	84.02
10" Masonry	Auditorium	273	12' - 0 7/16"	0' - 9 5/8"	215.08
6" Masonry	Auditorium	300	13' - 1 3/8"	0' - 5 5/8"	140.71
8" Masonry	Auditorium	355	15' - 2 3/8"	0' - 7 5/8"	225.33
8" Masonry	Auditorium	141	6' - 9"	0' - 7 5/8"	89.42
6" Masonry	Auditorium	285	13' - 1 3/8"	0' - 5 5/8"	133.76
6" Masonry	Auditorium	173	8' - 3 3/8"	0' - 5 5/8"	80.89
8" Masonry	Auditorium	121	5' - 3 1/4"	0' - 7 5/8"	75.41
8" Masonry	Auditorium	71	3' - 10"	0' - 7 5/8"	44.94
8" Masonry	Auditorium	121	5' - 3 1/4"	0' - 7 5/8"	75.41
8" Masonry	Auditorium	71	3' - 10"	0' - 7 5/8"	44.94
14" Masonry	Gymnasium	4,437	123' - 9 3/8"	1' - 1 5/8"	5,038.19
10" Masonry	Gymnasium	3,981	121' - 10 3/8"	0' - 9 5/8"	3,193.02
10" Masonry	Gymnasium	2,504	88' - 3"	0' - 9 5/8"	2,008.78
10" Masonry	Gymnasium	1,529	89' - 0"	0' - 9 5/8"	1,226.20
6" Masonry	Gymnasium	1,397	87' - 11"	0' - 5 5/8"	654.61
14" Masonry	Gymnasium	236	10' - 3 13/16"	1' - 1 5/8"	267.96
8" Masonry	Gymnasium	325	16' - 8 7/32"	0' - 7 5/8"	205.56
14" Masonry	Gymnasium	2,897	89' - 2"	1' - 1 5/8"	3,289.25
10" Masonry	Gymnasium	613	25' - 6 5/8"	0' - 9 5/8"	491.88
8" Masonry	Gymnasium	3,975	248' - 9 5/8"	0' - 7 5/8"	2,526.09
10" Masonry	Gymnasium	82	9' - 5 11/32"	0' - 9 5/8"	65.66
10" Masonry	Gymnasium	78	8' - 9 1/16"	0' - 9 5/8"	62.86
8" Masonry	Gymnasium	76	5' - 0 13/16"	0' - 7 5/8"	47.97
8" Masonry	Mech/Elec Wedge - Auto Strip	1,003	63' - 1"	0' - 7 5/8"	637.27
6" Masonry	Mech/Elec Wedge - Auto Strip	1,254	63' - 1"	0' - 5 5/8"	587.65
10" Masonry	Mech/Elec Wedge - Auto Strip	69	14' - 9 5/8"	0' - 9 5/8"	55.41
10" Masonry	Gymnasium	83	4' - 10 9/16"	0' - 9 5/8"	66.71
8" Masonry	Gymnasium	46	3' - 3 3/16"	0' - 7 5/8"	29.12
8" Masonry	Mech/Elec Wedge - Auto Strip	44	11' - 8"	0' - 7 5/8"	28.21
6" Masonry	Gymnasium	113	4' - 5 7/16"	0' - 5 5/8"	52.73
6" Masonry	Gymnasium	345	14' - 4 3/8"	0' - 5 5/8"	161.60
6" Masonry	Gymnasium	1,481	62' - 4"	0' - 5 5/8"	694.10
10" Masonry	Gymnasium	517	21' - 0 3/4"	0' - 9 5/8"	414.90
8" Masonry	Gymnasium	260	21' - 8 3/8"	0' - 7 5/8"	165.45
10" Masonry	Gymnasium	934	38' - 10 27/32"	0' - 9 5/8"	748.66
8" Masonry	Gymnasium	477	39' - 8 9/16"	0' - 7 5/8"	302.81

CMU Wall Schedule					
Type	Mark	Area (ft^2)	Length	Width	Volume (ft^3)
12" Masonry	Gymnasium	2,959	90' - 0 3/16"	0' - 11 5/8"	2,866.59
10" Masonry	Gymnasium	811	47' - 2 13/32"	0' - 9 5/8"	643.38
10" Masonry	Gymnasium	505	15' - 5 11/32"	0' - 9 5/8"	392.11
8" Masonry	Gymnasium	930	29' - 11 1/32"	0' - 7 5/8"	566.78
10" Masonry	Auditorium	95	8' - 10 5/8"	0' - 9 5/8"	76.02
10" Masonry	Auditorium	87	8' - 2 1/8"	0' - 9 5/8"	69.96
10" Masonry	Auditorium	87	8' - 2 1/8"	0' - 9 5/8"	69.96
10" Masonry	Auditorium	1,327	65' - 8 3/8"	0' - 9 5/8"	1,063.98
8" Masonry	Auditorium	798	66' - 6"	0' - 7 5/8"	507.06
8" Masonry	Auditorium	493	41' - 1 13/32"	0' - 7 5/8"	313.52
10" Masonry	Auditorium	836	40' - 6 21/32"	0' - 9 5/8"	663.49
10" Masonry	Auditorium	86	9' - 11 5/8"	0' - 9 5/8"	69.30
10" Masonry	Auditorium	1,268	63' - 5 9/32"	0' - 9 5/8"	1,016.21
10" Masonry	Auditorium	64	3' - 7 3/16"	0' - 9 5/8"	51.30
6" Masonry	Auditorium	169	11' - 4"	0' - 5 5/8"	78.98
6" Masonry	Auditorium	521	35' - 0 3/16"	0' - 5 5/8"	240.94
12" Masonry	Auditorium	1,155	40' - 11 3/16"	0' - 11 5/8"	1,117.93
12" Masonry	Auditorium	1,151	40' - 1 1/4"	0' - 11 5/8"	1,094.96
14" Masonry	Auditorium	1,294	44' - 6 3/4"	1' - 1 5/8"	1,468.93
6" Masonry	Auditorium	295	22' - 1 5/8"	0' - 5 5/8"	138.34
10" Masonry	Auditorium	649	22' - 1 7/16"	0' - 9 5/8"	520.43
14" Masonry	Auditorium	295	22' - 1 15/32"	1' - 1 5/8"	334.90
6" Masonry	Auditorium	297	9' - 8 13/16"	0' - 5 5/8"	130.79
10" Masonry	Auditorium	2,345	52' - 6"	0' - 9 5/8"	1,880.89
10" Masonry	Auditorium	973	61' - 1 13/16"	0' - 9 5/8"	780.69
8" Masonry	Auditorium	434	22' - 1 3/16"	0' - 7 5/8"	275.74
14" Masonry	Auditorium	3,739	114' - 11 5/32"	1' - 1 5/8"	4,244.80
14" Masonry	Auditorium	847	29' - 6 3/4"	1' - 1 5/8"	962.22
10" Masonry	Auditorium	629	21' - 9 13/16"	0' - 9 5/8"	504.71
8" Masonry	Auditorium	130	14' - 4 11/32"	0' - 7 5/8"	79.84
8" Masonry	Auditorium	130	14' - 4 11/32"	0' - 7 5/8"	79.84
8" Masonry	Auditorium	109	8' - 6"	0' - 7 5/8"	69.22
8" Masonry	Auditorium	109	8' - 6"	0' - 7 5/8"	69.22
12" Masonry	Auditorium	619	26' - 7 31/32"	0' - 11 5/8"	598.83
8" Masonry	Auditorium	308	19' - 3 1/4"	0' - 7 5/8"	194.21
8" Masonry	Auditorium	123	9' - 4 15/16"	0' - 7 5/8"	76.84
Generic - 2' 0"		20	0' - 8 15/16"	2' - 0"	32.92
Generic - 2' 0"		25	1' - 5 1/4"	2' - 0"	32.81
12" Masonry	Auditorium	38	5' - 3 5/32"	0' - 11 5/8"	36.23
12" Masonry	Auditorium	619	26' - 7 31/32"	0' - 11 5/8"	598.83
10" Masonry	Auditorium	2,017	45' - 8 3/4"	0' - 9 5/8"	1,617.97
12" Masonry	Auditorium	40	13' - 2 3/4"	0' - 11 5/8"	38.31
8" Masonry	Gymnasium	3,078	192' - 4 3/16"	0' - 7 5/8"	1,955.55
6" Masonry	Gymnasium	3,847	192' - 4 3/16"	0' - 5 5/8"	1,803.27
Total:		**194,871**			**159,335**

Appendix M

Areas 5, 6, & 7

Solarcrete™ Wall Schedule

T.C. Williams High School

Replacement Project

Solarcrete Wall Schedule					
Type	Mark	Area (ft^2)	Length	Width	Volume (ft^3)
Generic - 12"	Gymnasium	28	2' - 10"	1' - 0"	28.11
Generic - 12"	Gymnasium	148	9' - 7 23/32"	1' - 0"	147.86
Generic - 12"	Gymnasium	43	2' - 10"	1' - 0"	43.44
Generic - 12"	Gymnasium	46	2' - 9 15/16"	1' - 0"	45.53
Generic - 12"	Gymnasium	152	9' - 10 21/32"	1' - 0"	151.60
Generic - 12"	Mech/Elec Wedge - Auto Strip	2,454	121' - 10"	1' - 0"	2,454.33
Generic - 12"	Mech/Elec Wedge - Auto Strip	51	3' - 4"	1' - 0"	51.11
Generic - 12"	Mech/Elec Wedge - Auto Strip	215	15' - 0"	1' - 0"	214.67
Generic - 12"	Mech/Elec Wedge - Auto Strip	51	3' - 4"	1' - 0"	51.11
Generic - 12"	Mech/Elec Wedge - Auto Strip	2,933	145' - 3 11/16"	1' - 0"	2,926.19
Generic - 12"	Mech/Elec Wedge - Auto Strip	423	20' - 10 23/32"	1' - 0"	415.52
Generic - 12"	Mech/Elec Wedge - Auto Strip	503	25' - 2"	1' - 0"	503.33
Generic - 12"	Mech/Elec Wedge - Auto Strip	860	44' - 0"	1' - 0"	860.00
Generic - 12"	Mech/Elec Wedge - Auto Strip	1,155	57' - 9"	1' - 0"	1,155.00
Generic - 12"	Mech/Elec Wedge - Auto Strip	588	28' - 5"	1' - 0"	588.44
Generic - 12"	Auditorium	119	8' - 5"	1' - 0"	118.67
Generic - 12"	Auditorium	64	4' - 0"	1' - 0"	64.00
Generic - 12"	Auditorium	756	38' - 1"	1' - 0"	756.33
Generic - 12"	Auditorium	147	7' - 4"	1' - 0"	146.67
Generic - 12"	Auditorium	802	39' - 4 5/8"	1' - 0"	802.38
Generic - 12"	Auditorium	48	4' - 0"	1' - 0"	48.00
Generic - 12"	Auditorium	101	8' - 4 1/2"	1' - 0"	100.50
Generic - 12"	Auditorium	36	4' - 0"	1' - 0"	36.00
Generic - 12"	Auditorium	719	35' - 5 7/8"	1' - 0"	719.13
Generic - 12"	Auditorium	56	4' - 0"	1' - 0"	56.00
Generic - 12"	Auditorium	134	8' - 4 1/2"	1' - 0"	134.00
Generic - 12"	Auditorium	48	4' - 0"	1' - 0"	48.00
Generic - 12"	Auditorium	647	32' - 7 1/2"	1' - 0"	647.17
Generic - 12"	Auditorium	96	8' - 0"	1' - 0"	96.00
Generic - 12"	Auditorium	110	10' - 2"	1' - 0"	110.00
Generic - 12"	Auditorium	96	8' - 0"	1' - 0"	96.00
Generic - 12"	Gymnasium	148	7' - 5"	1' - 0"	148.33
Generic - 12"	Gymnasium	206	10' - 1 25/32"	1' - 0"	203.34
Generic - 12"	Gymnasium	193	9' - 7 15/16"	1' - 0"	193.25
Generic - 12"	Gymnasium	149	8' - 5 11/16"	1' - 0"	148.78
Generic - 12"	Gymnasium	1,505	75' - 2 3/4"	1' - 0"	1,504.60
Generic - 12"	Gymnasium	871	26' - 8"	1' - 0"	871.11
Generic - 12"	Gymnasium	501	14' - 10 1/16"	1' - 0"	501.03
Generic - 12"	Gymnasium	128	8' - 10"	1' - 0"	127.78
Generic - 12"	Gymnasium	281	10' - 5 31/32"	1' - 0"	280.62
Generic - 12"	Gymnasium	146	9' - 6"	1' - 0"	145.67
Generic - 12"	Gymnasium	46	2' - 0"	1' - 0"	46.00
Generic - 12"	Gymnasium	123	9' - 0"	1' - 0"	122.67
Generic - 12"	Gymnasium	46	2' - 0"	1' - 0"	46.00
Generic - 12"	Gymnasium	848	55' - 4"	1' - 0"	848.44
Generic - 12"	Gymnasium	118	7' - 8"	1' - 0"	117.56
Generic - 12"	Gymnasium	118	7' - 8"	1' - 0"	117.56

Solarcrete Wall Schedule					
Type	Mark	Area (ft^2)	Length	Width	Volume (ft^3)
Generic - 12"	Gymnasium	118	7' - 8"	1' - 0"	117.56
Generic - 12"	Gymnasium	190	11' - 11 15/16"	1' - 0"	190.33
Generic - 12"	Gymnasium	897	56' - 6 3/8"	1' - 0"	896.50
Generic - 12"	Gymnasium	934	59' - 4 1/16"	1' - 0"	933.81
Generic - 12"	Gymnasium	799	49' - 11 3/8"	1' - 0"	799.17
Generic - 12"	Gymnasium	625	31' - 3"	1' - 0"	625.00
Generic - 12"	Gymnasium	915	31' - 3"	1' - 0"	915.13
Generic - 12"	Gymnasium	2,088	73' - 10"	1' - 0"	2,087.89
Generic - 12"	Gymnasium	995	62' - 2"	1' - 0"	994.67
Generic - 12"	Gymnasium	867	55' - 2 3/8"	1' - 0"	867.17
Generic - 12"	Gymnasium	831	52' - 5"	1' - 0"	830.67
Generic - 12"	Mech/Elec Wedge - Auto Strip	931	59' - 2"	1' - 0"	930.67
Generic - 12"	Auditorium	580	28' - 9 3/32"	1' - 0"	572.91
Generic - 12"	Gymnasium	127	4' - 5"	1' - 0"	126.61
Generic - 12"	Gymnasium	446	13' - 8"	1' - 0"	446.44
Generic - 12"	Gymnasium	335	16' - 2 17/32"	1' - 0"	332.22
Generic - 12"	Gymnasium	7,404	205' - 8"	1' - 0"	7,404.00
Generic - 12"	Gymnasium	4,452	123' - 8"	1' - 0"	4,452.00
Generic - 12"	Gymnasium	7,368	205' - 8"	1' - 0"	7,368.00
Generic - 12"	Gymnasium	2,690	93' - 10"	1' - 0"	2,689.89
Generic - 12"	Gymnasium	1,663	59' - 0"	1' - 0"	1,662.67
Generic - 12"	Gymnasium	57	2' - 0"	1' - 0"	57.33
Generic - 12"	Gymnasium	201	8' - 0"	1' - 0"	200.67
Generic - 12"	Gymnasium	57	2' - 0"	1' - 0"	57.33
Generic - 12"	Gymnasium	215	8' - 6"	1' - 0"	215.00
Generic - 12"	Gymnasium	65	1' - 7 3/8"	1' - 0"	61.13
Generic - 12"	Gymnasium	1,720	60' - 5 3/4"	1' - 0"	1,718.98
Generic - 12"	Mech/Elec Wedge - Auto Strip	4,304	269' - 0"	1' - 0"	4,304.00
Generic - 12"	Mech/Elec Wedge - Auto Strip	1,232	62' - 6"	1' - 0"	1,232.00
Generic - 12"	Mech/Elec Wedge - Auto Strip	984	62' - 6"	1' - 0"	984.00
Generic - 12"	Mech/Elec Wedge - Auto Strip	53	3' - 4"	1' - 0"	53.33
Generic - 12"	Mech/Elec Wedge - Auto Strip	125	7' - 10"	1' - 0"	125.33
Generic - 12"	Mech/Elec Wedge - Auto Strip	37	3' - 4"	1' - 0"	37.33
Generic - 12"	Mech/Elec Wedge - Auto Strip	32	2' - 0"	1' - 0"	32.00
Generic - 12"	Mech/Elec Wedge - Auto Strip	125	7' - 10"	1' - 0"	125.33
Generic - 12"	Mech/Elec Wedge - Auto Strip	16	2' - 0"	1' - 0"	16.00
Generic - 12"	Gymnasium	699	44' - 2"	1' - 0"	698.67
Generic - 12"	Gymnasium	670	41' - 10 1/4"	1' - 0"	669.67
Generic - 12"	Gymnasium	625	39' - 0 5/8"	1' - 0"	624.83
Generic - 12"	Auditorium	92	13' - 8 7/16"	1' - 0"	91.62
Generic - 12"	Auditorium	469	21' - 0 11/16"	1' - 0"	463.52
Generic - 12"	Auditorium	3,640	111' - 5"	1' - 0"	3,639.61
Generic - 12"	Auditorium	4,462	135' - 3 5/16"	1' - 0"	4,452.46
Generic - 12"	Auditorium	461	29' - 10"	1' - 0"	461.33
Generic - 12"	Auditorium	461	29' - 10"	1' - 0"	461.33
Generic - 12"	Auditorium	323	20' - 8"	1' - 0"	322.67
Generic - 12"	Auditorium	293	18' - 4"	1' - 0"	293.33

Solarcrete Wall Schedule					
Type	Mark	Area (ft^2)	Length	Width	Volume (ft^3)
Generic - 12"	Auditorium	836	29' - 8"	1' - 0"	836.11
Generic - 12"	Auditorium	970	72' - 6 1/4"	1' - 0"	964.46
Generic - 12"	Auditorium	44	3' - 0 7/32"	1' - 0"	38.47
Generic - 12"	Auditorium	1,173	41' - 5 1/32"	1' - 0"	1,173.03
Generic - 12"	Mech/Elec Wedge - Auto Strip	1,236	77' - 10 11/16"	1' - 0"	1,224.64
Generic - 12"	Mech/Elec Wedge - Auto Strip	259	16' - 2"	1' - 0"	258.67
Generic - 12"	Mech/Elec Wedge - Auto Strip	339	21' - 2"	1' - 0"	338.67
Generic - 12"	Mech/Elec Wedge - Auto Strip	141	8' - 10"	1' - 0"	141.33
Generic - 12"	Mech/Elec Wedge - Auto Strip	123	7' - 8"	1' - 0"	122.67
Generic - 12"	Mech/Elec Wedge - Auto Strip	848	53' - 0"	1' - 0"	848.00
Generic - 12"	Auditorium	464	14' - 10 25/32"	1' - 0"	456.79
Generic - 12"	Auditorium	428	28' - 8 7/32"	1' - 0"	423.96
Generic - 12"	Auditorium	51	6' - 9 9/32"	1' - 0"	50.04
Generic - 12"	Auditorium	128	8' - 2"	1' - 0"	127.78
Generic - 12"	Auditorium	870	37' - 2"	1' - 0"	845.00
Generic - 12"	Auditorium	201	8' - 4 1/8"	1' - 0"	195.84
Generic - 12"	Auditorium	131	6' - 1 11/32"	1' - 0"	112.15
Generic - 12"	Auditorium	228	10' - 8 13/16"	1' - 0"	226.51
Generic - 12"	Auditorium	66	2' - 10"	1' - 0"	66.11
Generic - 12"	Auditorium	167	8' - 2"	1' - 0"	167.22
Generic - 12"	Auditorium	237	10' - 6 13/16"	1' - 0"	234.63
Generic - 12"	Auditorium	86	3' - 8"	1' - 0"	85.56
Generic - 12"	Auditorium	144	6' - 2"	1' - 0"	143.89
Generic - 12"	Auditorium	62	3' - 8"	1' - 0"	62.22
Generic - 12"	Auditorium	132	5' - 8"	1' - 0"	132.22
Generic - 12"	Auditorium	738	32' - 1 3/32"	1' - 0"	737.04
Generic - 12"	Auditorium	870	37' - 2"	1' - 0"	845.00
Generic - 12"	Auditorium	201	8' - 4 1/8"	1' - 0"	195.84
Generic - 12"	Auditorium	131	6' - 1 11/32"	1' - 0"	112.15
Generic - 12"	Auditorium	228	10' - 8 13/16"	1' - 0"	226.51
Generic - 12"	Auditorium	323	14' - 10"	1' - 0"	322.78
Generic - 12"	Auditorium	237	10' - 6 13/16"	1' - 0"	234.63
Generic - 12"	Auditorium	86	3' - 8"	1' - 0"	85.56
Generic - 12"	Auditorium	144	6' - 2"	1' - 0"	143.89
Generic - 12"	Auditorium	62	3' - 8"	1' - 0"	62.22
Generic - 12"	Auditorium	132	6' - 0 25/32"	1' - 0"	129.53
Generic - 12"	Auditorium	286	12' - 6 17/32"	1' - 0"	279.61
Generic - 12"	Auditorium	303	13' - 0"	1' - 0"	303.33
Generic - 12"	Auditorium	342	14' - 8"	1' - 0"	342.22
Generic - 12"	Auditorium	140	7' - 0"	1' - 0"	140.00
Generic - 12"	Auditorium	280	13' - 0"	1' - 0"	280.00
Generic - 12"	Auditorium	167	8' - 2"	1' - 0"	167.22
Generic - 12"	Auditorium	131	5' - 5 13/16"	1' - 0"	127.57
Generic - 12"	Auditorium	70	4' - 0"	1' - 0"	70.00
Generic - 12"	Auditorium	131	5' - 5 13/16"	1' - 0"	127.57
Generic - 12"	Auditorium	70	4' - 0"	1' - 0"	70.00
Generic - 12"	Gymnasium	4,472	123' - 8"	1' - 0"	4,471.67

Solarcrete Wall Schedule					
Type	Mark	Area (ft^2)	Length	Width	Volume (ft^3)
Generic - 12"	Gymnasium	1,528	89' - 1"	1' - 0"	1,528.22
Generic - 12"	Gymnasium	2,896	89' - 2"	1' - 0"	2,896.44
Generic - 12"	Gymnasium	834	35' - 0 5/8"	1' - 0"	833.58
Generic - 12"	Gymnasium	84	9' - 7 23/32"	1' - 0"	83.58
Generic - 12"	Gymnasium	81	9' - 10 1/16"	1' - 0"	80.59
Generic - 12"	Mech/Elec Wedge - Auto Strip	1,250	63' - 0"	1' - 0"	1,250.00
Generic - 12"	Mech/Elec Wedge - Auto Strip	70	15' - 0"	1' - 0"	70.00
Generic - 12"	Mech/Elec Wedge - Auto Strip	45	11' - 10"	1' - 0"	45.33
Generic - 12"	Gymnasium	125	4' - 8 5/8"	1' - 0"	125.25
Generic - 12"	Gymnasium	332	13' - 10"	1' - 0"	332.00
Generic - 12"	Gymnasium	1,468	62' - 2"	1' - 0"	1,468.00
Generic - 12"	Gymnasium	516	20' - 8 3/8"	1' - 0"	516.42
Generic - 12"	Gymnasium	930	38' - 8 27/32"	1' - 0"	929.37
Generic - 12"	Gymnasium	2,921	89' - 5"	1' - 0"	2,920.94
Generic - 12"	Gymnasium	795	46' - 6 3/16"	1' - 0"	783.32
Generic - 10"	Gymnasium	504	15' - 7 31/32"	0' - 10"	405.40
Generic - 12"	Gymnasium	937	29' - 3 7/16"	1' - 0"	882.41
Generic - 12"	Auditorium	96	9' - 0"	1' - 0"	96.00
Generic - 12"	Auditorium	89	8' - 4 1/2"	1' - 0"	89.33
Generic - 12"	Auditorium	89	8' - 4 1/2"	1' - 0"	89.33
Generic - 12"	Auditorium	1,326	65' - 6"	1' - 0"	1,325.67
Generic - 12"	Auditorium	839	40' - 5"	1' - 0"	828.40
Generic - 12"	Auditorium	88	10' - 2"	1' - 0"	88.11
Generic - 12"	Auditorium	1,268	63' - 5 3/16"	1' - 0"	1,266.42
Generic - 12"	Auditorium	212	11' - 4"	1' - 0"	212.00
Generic - 12"	Auditorium	1,219	42' - 11 1/2"	1' - 0"	1,181.51
Generic - 12"	Auditorium	1,297	44' - 9 1/32"	1' - 0"	1,297.23
Generic - 12"	Auditorium	293	22' - 0"	1' - 0"	293.33
Generic - 12"	Auditorium	1,271	44' - 7 31/32"	1' - 0"	1,271.38
Generic - 12"	Auditorium	976	61' - 6"	1' - 0"	976.00
Generic - 12"	Auditorium	430	22' - 6"	1' - 0"	430.00
Generic - 12"	Auditorium	3,738	114' - 10 31/32"	1' - 0"	3,737.52
Generic - 12"	Auditorium	637	22' - 0"	1' - 0"	636.67
Generic - 12"	Auditorium	133	14' - 9 9/16"	1' - 0"	126.16
Generic - 12"	Auditorium	133	14' - 9 9/16"	1' - 0"	126.16
Generic - 12"	Auditorium	106	8' - 7"	1' - 0"	106.17
Generic - 12"	Auditorium	106	8' - 7"	1' - 0"	106.17
Generic - 12"	Auditorium	618	26' - 7 9/16"	1' - 0"	617.26
Generic - 12"	Auditorium	290	19' - 9 1/2"	1' - 0"	286.84
Generic - 12"	Auditorium	141	10' - 0 1/4"	1' - 0"	137.96
Generic - 12"	Auditorium	16	0' - 5 5/32"	1' - 0"	14.52
Generic - 12"	Auditorium	37	1' - 6 3/16"	1' - 0"	32.09
Generic - 12"	Auditorium	51	6' - 9 9/32"	1' - 0"	50.04
Generic - 12"	Auditorium	618	26' - 7 9/16"	1' - 0"	617.26
Generic - 12"	Gymnasium	3,847	192' - 4"	1' - 0"	3,846.67
Total:		**129,917**			**129,467**

Appendix N

Areas 5, 6, & 7

CMU Estimate

T.C. Williams High School

Replacement Project

T.C. Williams High School

CMU Estimate

QTO - Current Construction			Schedule Impact				Labor				Cost Impact						
	Wall Area	Units	Daily Output*	Units	Duration	Units	Rate	Units	Labor Hours	Units	Material	Units	Cost	Labor	Units	Cost	Total Cost
Gymnasium			**Gymnasium**				**Gymnasium**				**Gymnasium**						
10" CMU	49,827	sf	280	sf / day	178.0	days	0.143	hours / sf	7,125	mhrs	6.35	$ / sf	316,401	5.31	$ / sf	264,581	580,983
12" CMU	14,828	sf	265	sf / day	56.0	days	0.181	hours / sf	2,684	mhrs	6.95	$ / sf	103,055	6.05	$ / sf	89,709	192,764
14" CMU	19,440	sf	255	sf / day	76.2	days	0.188	hours / sf	3,655	mhrs	7.45	$ / sf	144,828	6.95	$ / sf	135,108	279,936
6" CMU	7,469	sf	325	sf / day	23.0	days	0.123	hours / sf	919	mhrs	4.94	$ / sf	36,897	4.22	$ / sf	31,519	68,416
8" CMU	19,007	sf	300	sf / day	63.4	days	0.133	hours / sf	2,528	mhrs	5.75	$ / sf	109,290	4.57	$ / sf	86,862	196,152
Sub-Total:	**110,571**	**sf**			**396.5**	**days**			**16,910**	**mhrs**			**$710,471**			**$607,780**	**$1,318,251**
Auditorium			**Auditorium**				**Auditorium**				**Auditorium**						
10" CMU	19,046	sf	280	sf / day	68.0	days	0.143	hours / sf	2,724	mhrs	6.35	$ / sf	120,942	5.31	$ / sf	101,134	222,076
12" CMU	8,281	sf	265	sf / day	31.2	days	0.181	hours / sf	1,499	mhrs	6.95	$ / sf	57,553	6.05	$ / sf	50,100	107,653
14" CMU	13,981	sf	255	sf / day	54.8	days	0.188	hours / sf	2,628	mhrs	7.45	$ / sf	104,158	6.95	$ / sf	97,168	201,326
6" CMU	8,661	sf	325	sf / day	26.6	days	0.123	hours / sf	1,065	mhrs	4.94	$ / sf	42,785	4.22	$ / sf	36,549	79,335
8" CMU	10,857	sf	300	sf / day	36.2	days	0.133	hours / sf	1,444	mhrs	5.75	$ / sf	62,428	4.57	$ / sf	49,616	112,044
Sub-Total:	**60,826**	**sf**			**216.9**	**days**			**9,360**	**mhrs**			**$387,867**			**$334,568**	**$722,435**
Mech/Elec Wedge - Auto Strip			**Mech/Elec Wedge - Auto Strip**				**Mech/Elec Wedge - Auto Strip**				**Mech/Elec Wedge - Auto Strip**						
10" CMU	16,587	sf	280	sf / day	59.2	days	0.143	hours / sf	2,372	mhrs	6.35	$ / sf	105,327	5.31	$ / sf	88,077	193,404
6" CMU	1,625	sf	325	sf / day	5.0	days	0.123	hours / sf	200	mhrs	4.94	$ / sf	8,028	4.22	$ / sf	6,858	14,885
8" CMU	5,217	sf	300	sf / day	17.4	days	0.133	hours / sf	694	mhrs	5.75	$ / sf	29,998	4.57	$ / sf	23,842	53,839
Sub-Total:	**23,429**	**sf**			**81.6**	**days**			**3,266**	**mhrs**			**$143,353**			**$118,776**	**$262,129**
Total:	**194,826**	**sf**			**695.0**	**days**			**29,536**	**mhrs**			**$1,241,690**			**$1,061,124**	**$2,302,815**
											City Cost Index**						
											Alexandria, Virginia		0.923			0.713	
													$1,146,080			**$756,582**	**$1,902,662**

Note:

* Based on Labor Output Displayed in Labor Column

** City Cost Index for Masonry

Appendix P

Areas 5, 6, & 7

Solarcrete™ Estimate

T.C. Williams High School

Replacement Project

T.C. Williams High School
Solarcrete Estimate

QTO - Solarcrete System					Schedule Impact - EPS				Schedule Impact - Shotcrete				Labor - EPS				Labor - Shotcrete			
	Wall Area	Units	Wall Length	Units	Daily Output*	Units	Duration	Units	Daily Output*	Units	Duration	Units	Rate	Units	Labor Hours	Units	Rate	Units	Labor Hours	Units
Gymnasium					**Gymnasium**								**Gymnasium**							
12" Panel	66,167	sf	2,595	lf	200	lf / day	13.0	days	2000	sf / day	66.2	days	0.48	hours / lf	1,246	mhrs	0.048	hours / sf	3,176	mhrs
Sub-Total:	**66,167**	**sf**	**2,595**	**lf**			**13.0**	**days**			**66.2**	**days**			**1,246**	**mhrs**			**3,176**	**mhrs**
Auditorium					**Auditorium**								**Auditorium**							
12" Panel	42,367	sf	1,900	lf	200	lf / day	9.5	days	2000	sf / day	42.4	days	0.48	hours / lf	912	mhrs	0.048	hours / sf	2,034	mhrs
Sub-Total:	**42,367**	**sf**	**1,900**	**lf**			**9.5**	**days**			**42.4**	**days**			**912**	**mhrs**			**2,034**	**mhrs**
Mech/Elec Wedge - Auto Strip					**Mech/Elec Wedge - Auto Strip**								**Mech/Elec Wedge - Auto Strip**							
12" Panel	21,383	sf	1,220	lf	200	lf / day	6.1	days	2000	sf / day	21.4	days	0.48	hours / lf	586	mhrs	0.048	hours / sf	1,026	mhrs
Sub-Total:	**21,383**	**sf**	**1,220**	**lf**			**6.1**	**days**			**21.4**	**days**			**586**	**mhrs**			**1,026**	**mhrs**
Total:	**129,917**	**sf**	**5,715**	**lf**			**28.6**	**days**			**129.9**	**days**			**2,743**	**mhrs**			**6,236**	**mhrs**
					Total Schedule Impact:		**158.5**	**days**					**Total Labor:**		**8,979**	**mhrs**				

Note:
* Based on Labor Output Displayed in Labor Column
** City Cost Index for Concrete

T.C. Williams High School
Solarcrete Estimate

QTO - Solarcrete System					Cost Impact									
	Wall Area	Units	Wall Length	Units	Material	Units	Cost	Labor	Units	Cost	Equip.	Units	Cost	Total Cost
Gymnasium					**Gymnasium**									
12" Panel	66,167	sf	2,595	lf	9.8	$ / sf	648,437	5.23	$ / sf	346,053	1.06	$ / sf	70,137	1,064,627
Sub-Total:	**66,167**	**sf**	**2,595**	**lf**			**$648,437**			**$346,053**			**$70,137**	**$1,064,627**
Auditorium					**Auditorium**									
12" Panel	42,367	sf	1,900	lf	9.8	$ / sf	415,197	5.23	$ / sf	221,579	1.06	$ / sf	44,909	681,685
Sub-Total:	**42,367**	**sf**	**1,900**	**lf**			**$415,197**			**$221,579**			**$44,909**	**$681,685**
Mech/Elec Wedge - Auto Strip					**Mech/Elec Wedge - Auto Strip**									
12" Panel	21,383	sf	1,220	lf	9.8	$ / sf	209,553	5.23	$ / sf	111,833	1.06	$ / sf	22,666	344,052
Sub-Total:	**21,383**	**sf**	**1,220**	**lf**			**$209,553**			**$111,833**			**$22,666**	**$344,052**
Total:	**129,917**	**sf**	**5,715**	**lf**			**$1,273,187**			**$679,466**			**$137,712**	**$2,090,365**
					City Cost Index**									
Chicago, Illinois:	$15.99				Alexandria, Virginia		1.088			0.787				
City Index (Concrete)	1.064						**$1,385,227**			**$534,740**			**$137,712**	**$2,057,679**
	$15.03													

APPENDIX S

Area 5

Gymnasium Structural Steel Estimate

T.C. Williams High School

Replacement Project

T.C. Williams High School																							
Gymnasium Structural Steel Estimate																							
Quantity Take-Off						Schedule Impact				Labor				Cost									
Count	Member	Size	Length	Converted	Units	Daily Output*	Units	Duration	Units	Rate	Units	Labor Hours	Units	Material	Units	Cost	Labor	Units	Cost	Equip.	Units	Cost	Total Cost
18	W-Wide Flange-Column	W14X145	32' - 8"	32.667	lf	940	lf / day	0.63	days	0.059	hours / lf	34.69	mhrs	151.34	$ / lf	$88,988.83	2.32	$ / lf	$1,364.17	1.52	$ / lf	$893.77	$91,246.77
4	W-Wide Flange-Column	W10X49	32' - 8"	32.667	lf	1024	lf / day	0.13	days	0.055	hours / lf	7.19	mhrs	51.17	$ / lf	6,686.28	2.13	$ / lf	278.32	1.39	$ / lf	181.63	7,146.23
2	W-Wide Flange	W14X48	29' - 11"	29.91667	lf	805	lf / day	0.07	days	0.070	hours / lf	4.19	mhrs	50.25	$ / lf	3,006.63	2.71	$ / lf	162.15	1.77	$ / lf	105.91	3,274.68
3	W-Wide Flange	W24X68	36' - 0"	36	lf	1110	lf / day	0.10	days	0.072	hours / lf	7.78	mhrs	71.00	$ / lf	7,668.00	2.84	$ / lf	306.72	1.37	$ / lf	147.96	8,122.68
2	W-Wide Flange	W21X62	36' - 0"	36	lf	1036	lf / day	0.07	days	0.077	hours / lf	5.54	mhrs	65.00	$ / lf	4,680.00	3.04	$ / lf	218.88	1.46	$ / lf	105.12	5,004.00
1	W-Wide Flange	W24X68	36' - 5 15/16"	36.49479	lf	1110	lf / day	0.03	days	0.072	hours / lf	2.63	mhrs	71.00	$ / lf	2,591.13	2.84	$ / lf	103.65	1.37	$ / lf	50.00	2,744.77
1	W-Wide Flange	W24X68	35' - 6 1/16"	35.50521	lf	1110	lf / day	0.03	days	0.072	hours / lf	2.56	mhrs	71.00	$ / lf	2,520.87	2.84	$ / lf	100.83	1.37	$ / lf	48.64	2,670.35
2	W-Wide Flange	W12X50	29' - 11"	29.91667	lf	750	lf / day	0.08	days	0.075	hours / lf	4.49	mhrs	52.50	$ / lf	3,141.25	2.90	$ / lf	173.52	1.90	$ / lf	113.68	3,428.45
4	W-Wide Flange	W8X21	24' - 11"	24.91667	lf	600	lf / day	0.17	days	0.093	hours / lf	9.27	mhrs	22.00	$ / lf	2,192.67	3.63	$ / lf	361.79	2.38	$ / lf	237.21	2,791.66
6	W-Wide Flange	W8X18	24' - 0"	24	lf	600	lf / day	0.24	days	0.093	hours / lf	13.39	mhrs	18.85	$ / lf	2,714.40	3.63	$ / lf	522.72	2.38	$ / lf	342.72	3,579.84
1	W-Wide Flange	W24X68	35' - 6 1/16"	35.50521	lf	1110	lf / day	0.03	days	0.072	hours / lf	2.56	mhrs	71.00	$ / lf	2,520.87	2.84	$ / lf	100.83	1.37	$ / lf	48.64	2,670.35
14	DLH-Series Bar Joist	68DLH19	121' - 10"	121.833	lf	2200	lf / day	0.78	days	0.036	hours / lf	61.40	mhrs	51.20	$ / lf	87,329.89	1.43	$ / lf	2,439.10	0.73	$ / lf	1,245.13	91,014.12
30	W-Wide Flange	W12X26	23' - 11"	23.91667	lf	880	lf / day	0.82	days	0.064	hours / lf	45.92	mhrs	27.00	$ / lf	19,372.50	2.48	$ / lf	1,779.40	1.62	$ / lf	1,162.35	22,314.25
			Sub-Total:	499.34	lf	Sub-Total Schedule Impact:		3.17	days	Sub-Total Labor:		201.60	mhrs	Sub-Total Cost:		$233,413			$7,912			$4,683	$246,008
			*****Total:**	**353.59**	**lf**	*****Total Schedule Impact:**		**1.58**	**days**	*****Total Labor:**		**94.28**	**mhrs**	*****Total Cost:**		**$126,711**			**$3,694**			**$2,275**	**$132,680**
														City Cost Index**									
														Alexandria, Virginia		1.000			0.964				
																$126,711			**$3,561**			**$2,275**	**$132,547**

Note:

* Based on Labor Output Displayed in Labor Column

** City Cost Index for Metals

*** Grey Shaded Region is Part of the Existing Design