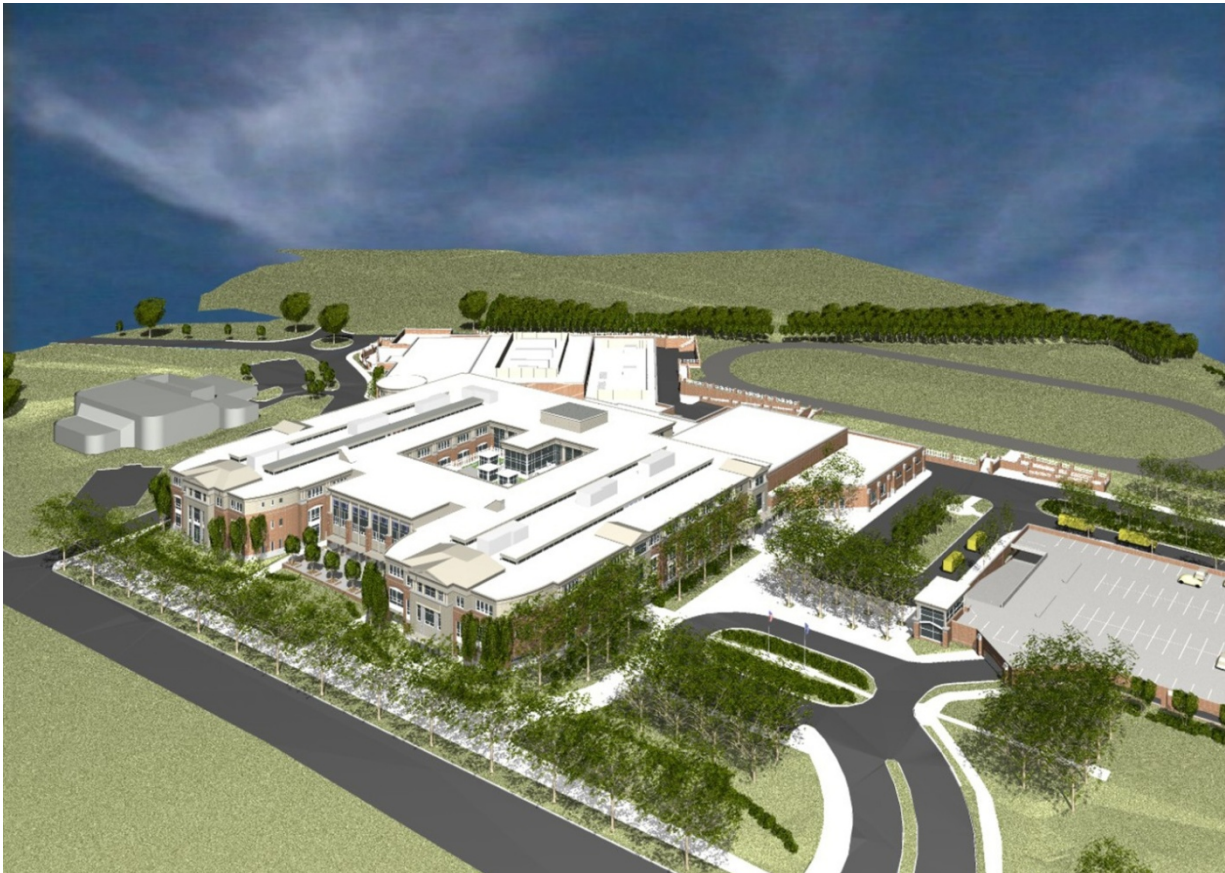


# T.C. WILLIAMS HIGH SCHOOL

ALEXANDRIA, VA



**CHRISTOPHER B. DEKER**

**STRUCTURAL OPTION**

**CONSTRUCTION MANAGEMENT BREADTH**

**09 APRIL 2008**

**FACULTY CONSULTANT: PROF PARFITT**

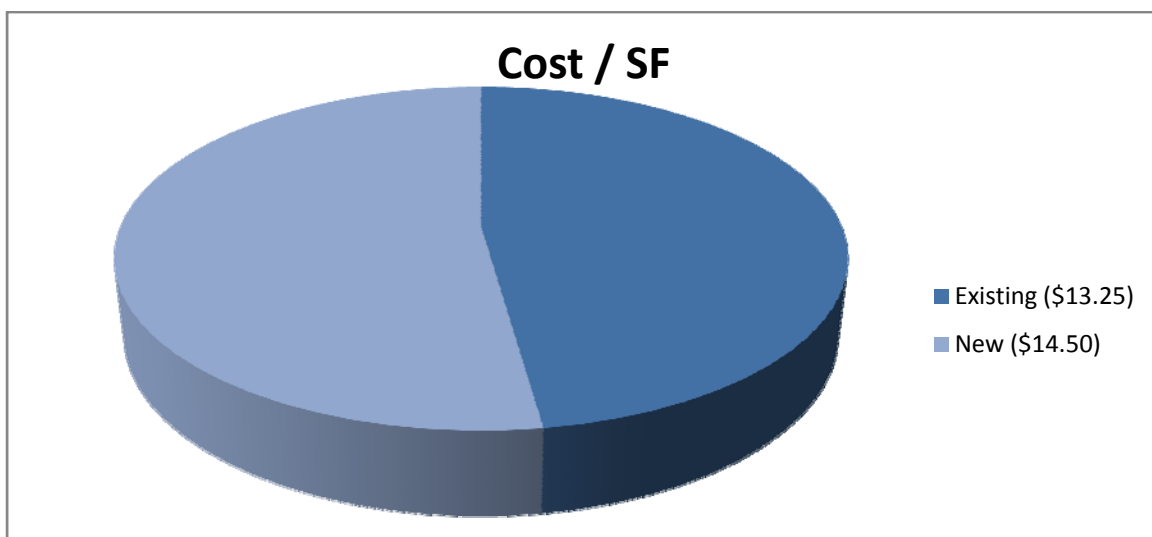
## CONSTRUCTION MANAGEMENT BREADTH

A Construction Management study will examine a cost analysis and the schedule impact between the existing and alternative structural systems. Both buildings will be assumed to be the same square footage, (approximately 108,000 SF), but the existing building will only be 3 stories in height, and the new building will be 5 stories in height. With the addition of two stories, cost would be much more of an impact on the redesign than what it was with the original design. RS Means and Microsoft Project will be the primary tools used in the new scheduling and design process in order to minimize costs as best as possible.

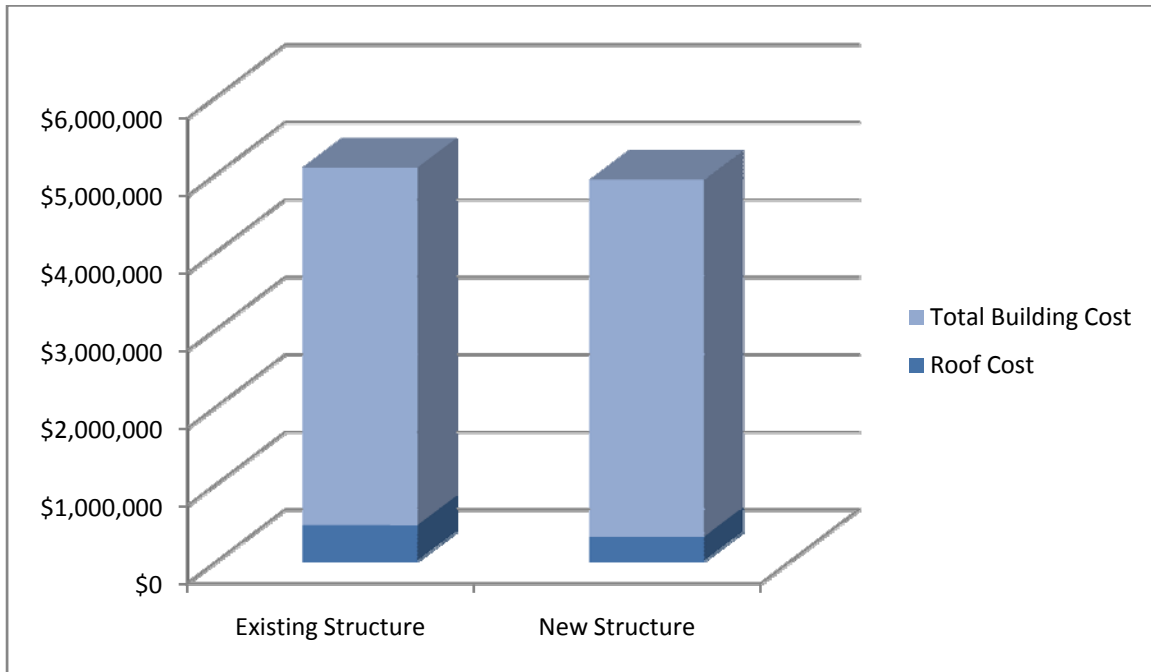
### COST IMPACTS

#### ROOF SYSTEM

In order to satisfy an architectural requirement, the roof system needed to be redone. With a more complicated roof system, comes a higher cost. Sizes were optimized as much as possible to keep costs down, but with the addition extra columns and girders, costs / square foot are expected to rise. The total calculated cost using RS Means of the existing structural roof system was \$463,568, which is approximately \$13.25 / SF. The total calculated cost using RS Means of the new structural roof system was \$313,061, which is approximately \$14.50 / SF. This is a total difference of \$1.25 / SF. Considering the roof is such a small part of the overall cost of the structure, this may turn out to be negligible.

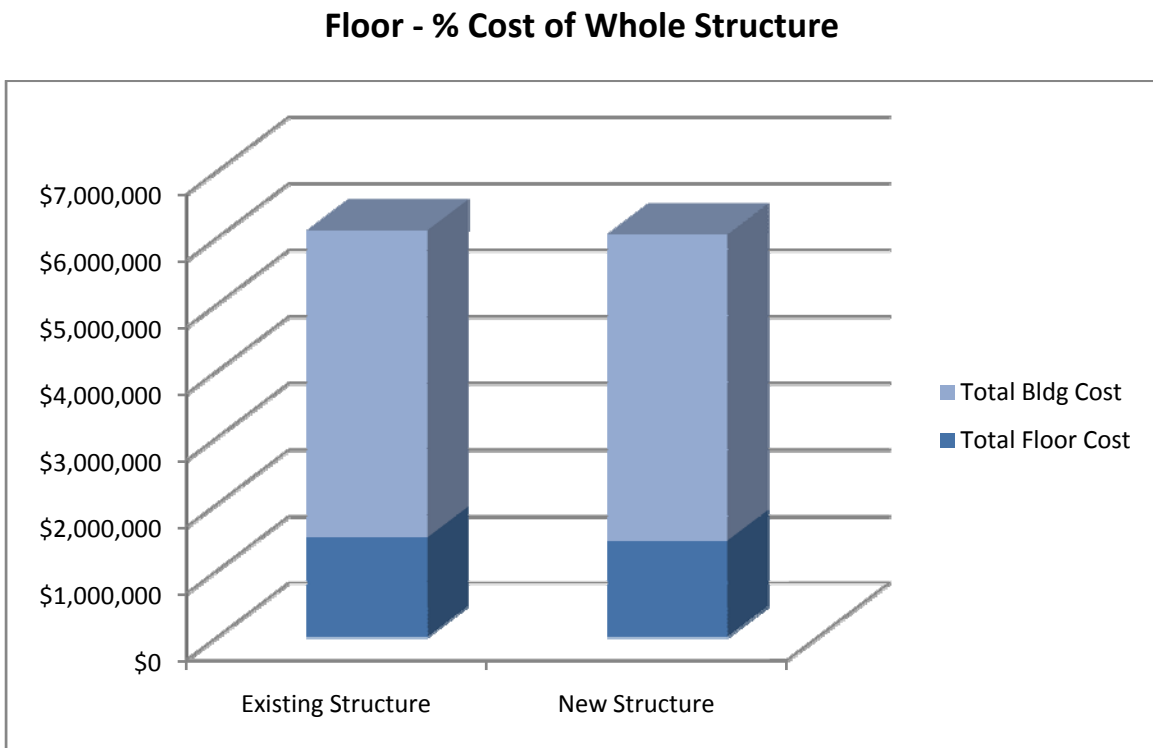
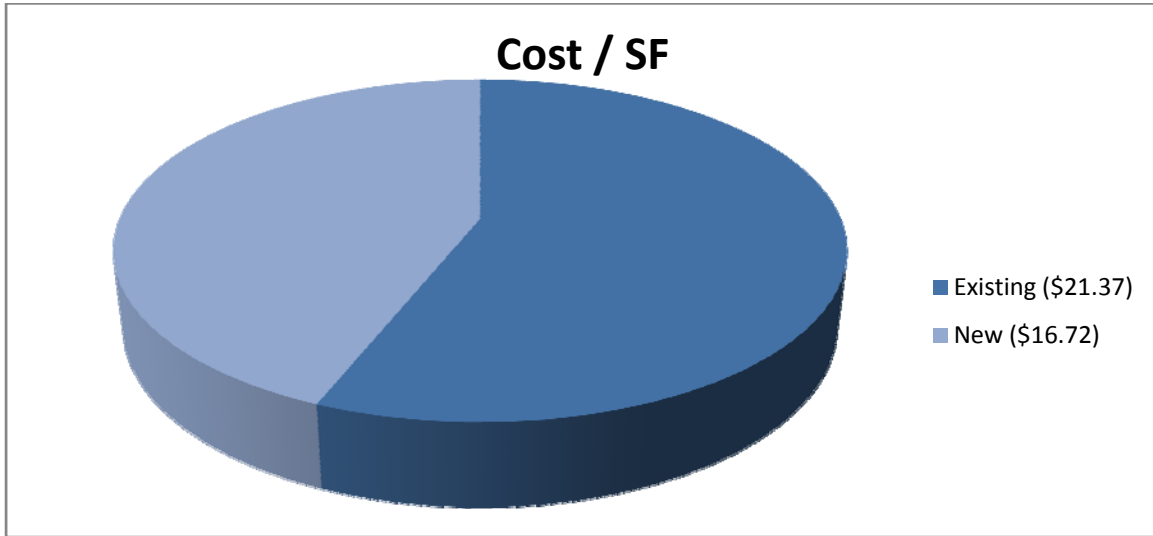


### Roof - % Cost of Whole Structure



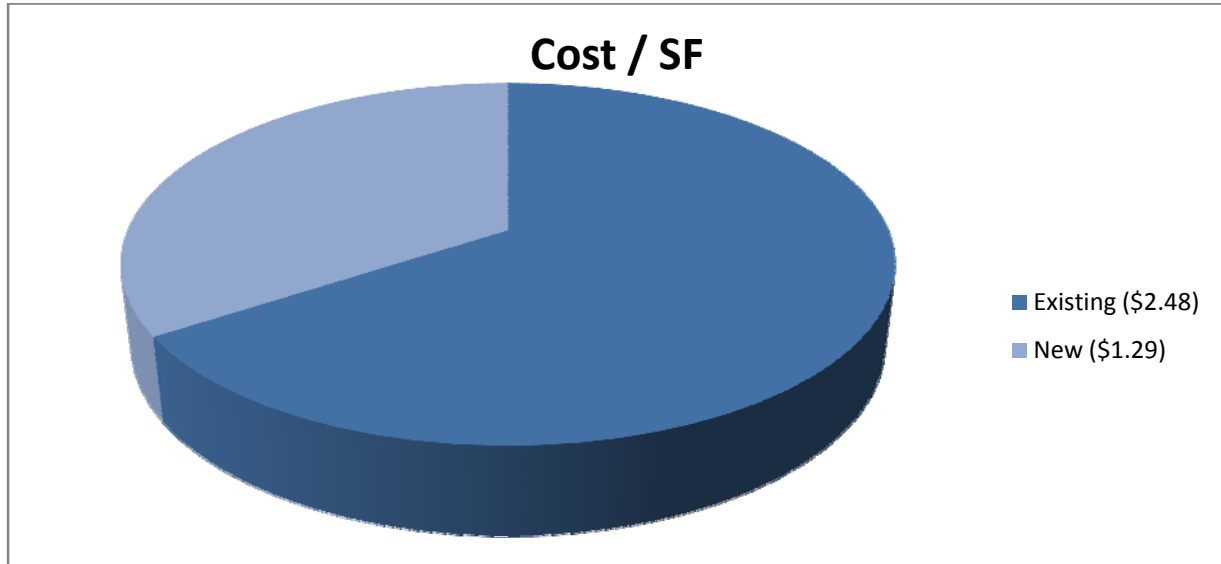
### FLOOR SYSTEM

In an attempt to reduce the cost per square foot of the floor system, a composite joist system was chosen. A joist system was chosen to try and limit the slab thickness, and composite action was chosen to limit the number of joists required and thereby reducing the cost of fireproofing. However, vibration issues forced the use of larger joist and girder sizes, raising the cost of the new system. Using RS Means the existing floor system was calculated to cost \$748,000 per floor, or \$1,496,000 for the total floor cost. The new floor system, using RS Means, was calculated to cost \$361,100 per floor, or \$1,444,500 for the total floor cost of the building. Cost per square foot of the existing system was computed to be approximately \$21.37 per square foot, compared to the new system which was computed to cost approximately \$16.72 per square foot. The difference is nearly \$4.65 per square foot, but with the increase of overall floor area above grade, the total costs of the floor systems are about even.

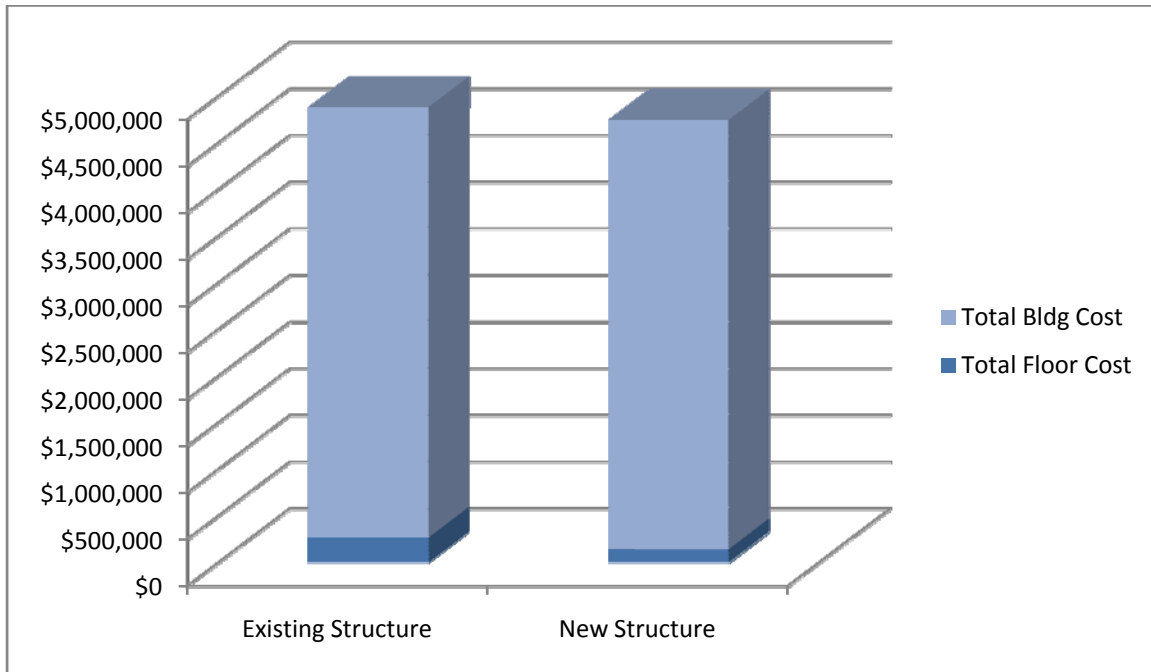


### LATERAL RESISTING SYSTEM

In an attempt to use a material already present as a partition, masonry shear walls were chosen as the material of choice for the redesign of the lateral force resisting system. These will replace the steel braced frames, which required a total of 4 in each direction, and will aim to reducing the cost of the structure. It was determined that 2 reinforced masonry shear walls in each direction was the minimum number to resist the required loads. RS Means was used to calculate the both systems. The existing system was found to cost \$267,500, which is approximately \$2.48 per square foot of the buildings floor area. The new system was found to cost \$139,510, which is approximately \$1.29 per square foot of the buildings floor area. These equate to approximately a \$1.19 difference in cost per square foot. This is significant cost savings for a lateral resisting system.

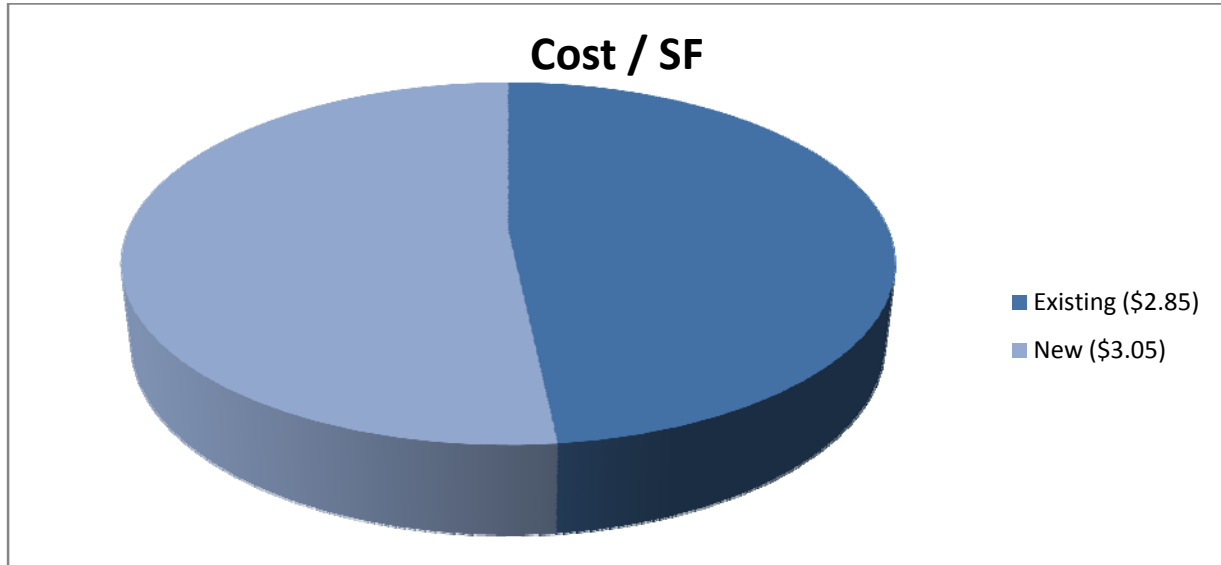


### Lateral System - % Cost of Whole Structure

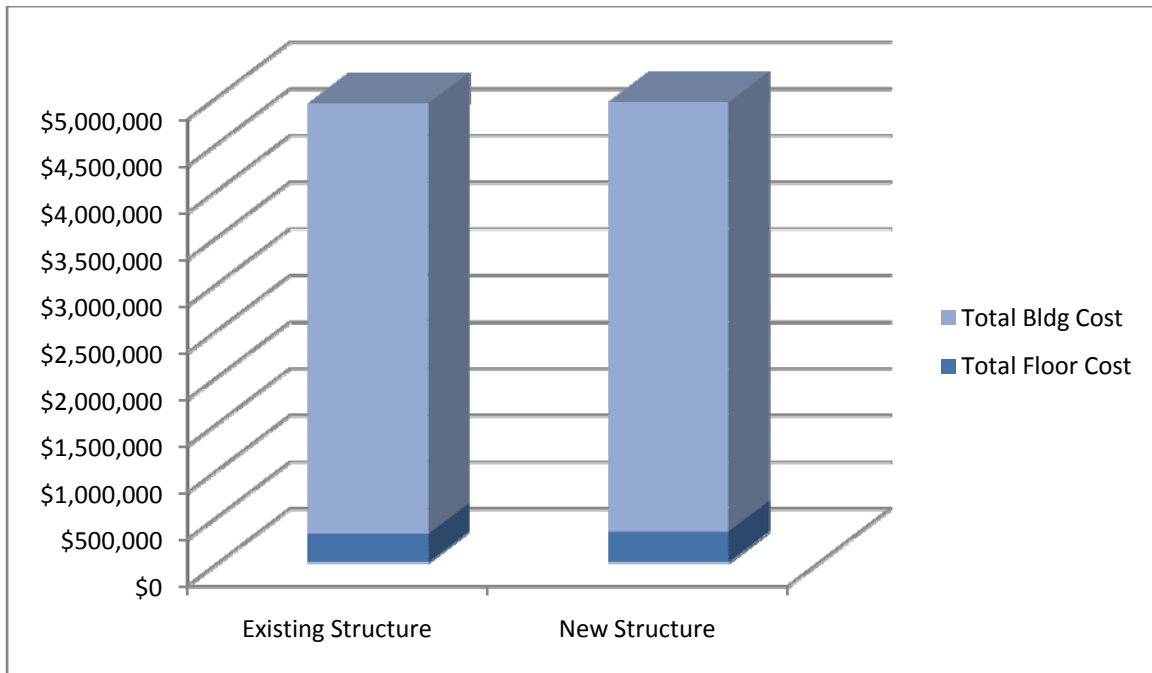


### COLUMNS

With the increase in building height from 45 feet to 75 feet, the columns are expected to change. A 5 story column is also unheard of so they will need to be spliced. The splice will be taken about 5 feet above the third floor, for both ease of construction and reduction of moment. A total cost of a splice is equivalent to about 500 pounds of steel or \$750 dollars. With both the increase of column sizes, along with splices, the cost per column will rise, however with a smaller building footprint; fewer columns will be needed to support the structure. The total cost of columns for the existing system, using RS Means, was calculated to cost \$307,820, which equates to approximately \$2.85 per square foot of building floor area. The total cost of columns for the new structural system, using RS Means, was calculated to cost \$329,160, which equates to approximately \$3.05 per square foot of building floor area. This difference is approximately \$0.20 per square foot, and is very minimal.

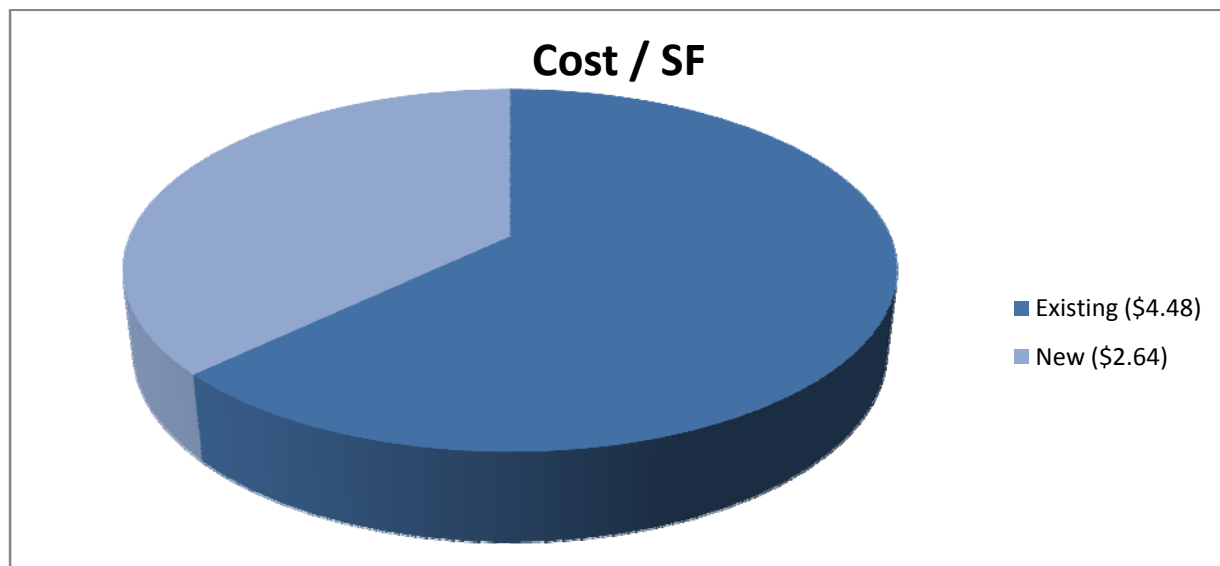


### Columns - % Cost of Whole Structure



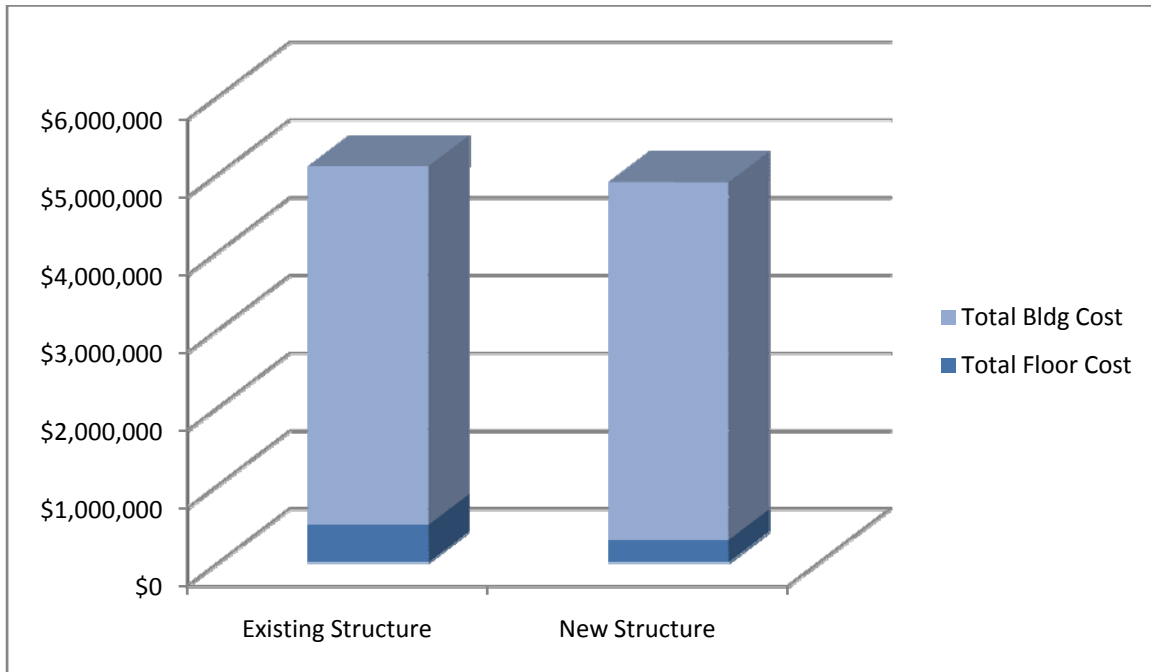
## FOUNDATIONS

Geopier's 'Rammed Aggregate Pier' soil reinforcement system was used to create a soil bearing capacity of 6 KSF. The number of piers required for the existing structure was calculated to be around 425 – 12 foot deep piers, compared to the new structure which was calculated to require around 234 – 12 foot deep piers. Total increase in footing sizes turned out to be pretty minimal. The existing foundation and slab on grade system was calculated using RS Means to cost \$484,120, which is about \$12.57 per square foot of ground area, and \$4.48 per square foot of building area. The new foundation and slab on grade system was calculated using RS Means to cost \$285,466, which is about \$13.22 per square foot of ground area, and \$2.64 per square foot of building area. This was expected as the cost of the building footprint shrunk, reducing the overall cost of a foundation system. A difference of \$1.84 per square foot of building floor area was saved.



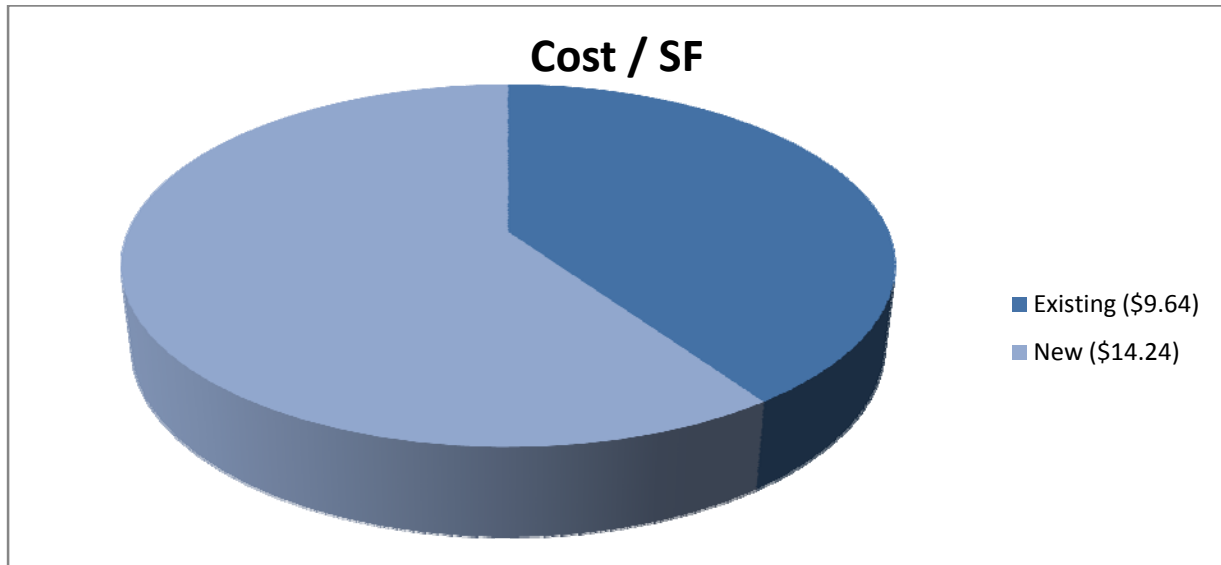


### Foundations - % Cost of Whole Structure

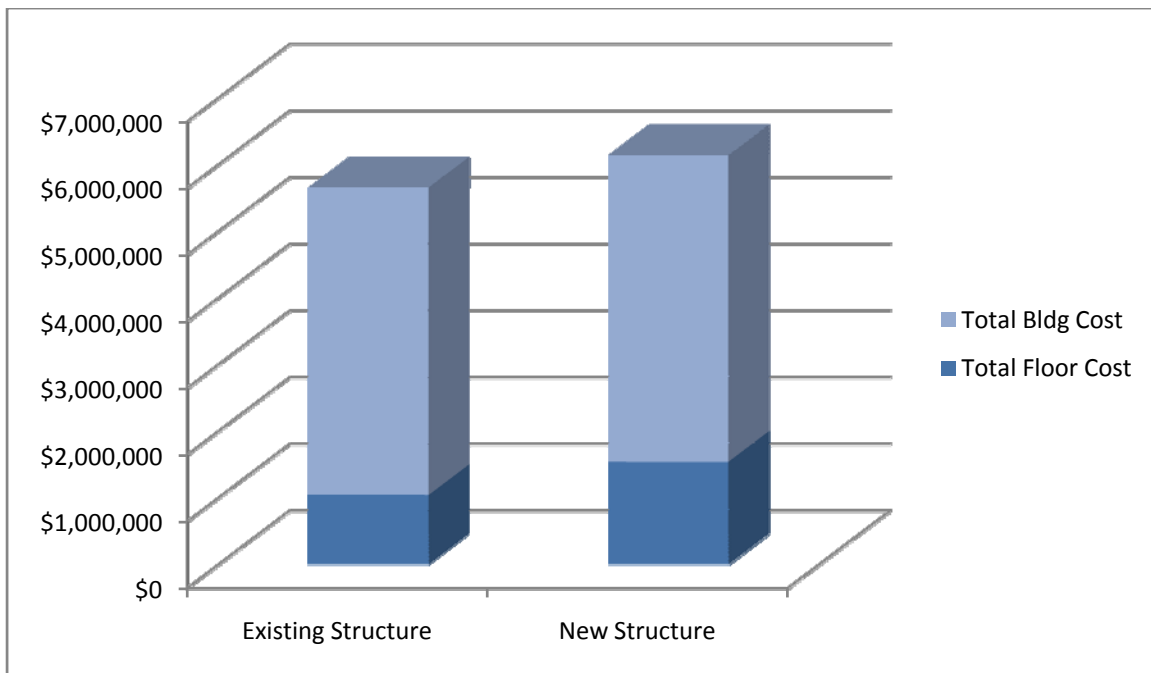


### EXTERIOR WALL

With the decrease of the building footprint, and the increase of the buildings height, the overall square footage of the exterior wall was expected to change. The building materials were summed up as best as possible through the use of architectural elevations. The existing wall was calculated to cost \$1,041,200, which is approximately \$9.64 per square foot of building area. The new wall system was calculated to cost \$1,538,300, which is approximately \$14.24 per square foot of building area. This is a relatively large difference of \$4.60 per square foot of floor area. Interior partitions turned out to be about the same amount of square footage, and totaled about \$556,000.



### Exterior Wall - % Cost of Whole Structure



## NEW PROPOSED STRUCTURAL SYSTEM COST COMPARISONS

- STRUCTURAL ROOF SYSTEM
  - COST / SF ROOF AREA (+)1.25
  - COST / SF TOTAL BLDG AREA (-)1.39
- STRUCTURAL FLOOR SYSTEM
  - COST / SF FLOOR AREA (-4.65)
  - COST / SF TOTAL BLDG AREA (-)0.48
- LATERAL FORCE RESISTING SYSTEM
  - COST / SF TOTAL BLDG AREA (-)1.19
- COLUMNS
  - COST / SF TOTAL BLDG AREA (+)0.20
- FOUNDATIONS
  - COST / SF FOUNDATION AREA (+)0.65
  - COST / SF TOTAL BLDG AREA (-)1.84
- EXTERIOR WALLS
  - COST / SF TOTAL BLDG AREA (+)4.60
- INTERIOR PARTITION MASONRY
  - COST / SF TOTAL BLDG AREA (~)0.00

**SCHEDULING IMPACTS**

Both schedules start on July 02, 2004. The existing buildings schedule, using information from RS Means, was planned to finish on November 08, 2005. The new redesigned building schedule was planned to finish on November 25, 2005. This is a difference of about 2.5 weeks. The original thought was to reduce the amount of time spent on the foundation work, to decrease the total buildings schedule. In fact it is estimated that construction may begin 2.5 months earlier with the reduction in foundation work. However the main reasoning for prolonging construction with the new building schedule, is the masonry shear walls. The shear walls where a major factor in saving money, but construction couldn't be completed on the floor above the shear wall until the wall was completed, leading to much down time. Composite joists were able to be constructed twice as fast compared to the beams. However, the difference in time savings between joists and beams is pretty much negligible when compared to that of the whole schedule. If 2.5 weeks of scheduling is thought to be a problem on a project of this scale, then it would be recommended to stick with the braced frames.