Technical Assignment 3

Alternative Methods Analysis

Ingleside at King Farm

Rockville, MD

Joseph Podwats
2008-2009 construction management option
AE Faculty Consultant: Dr. David Riley
Date of Submission: 11/21/2008

Table of Contents

Executive Summary

Constructability Challenges:

In a project manager interview, it was learned that Ingleside at King Farm was not difficult from a constructability standpoint. The single most difficult part of this project from a constructability standpoint was that the bid documents were not ready for bidding. In looking at the project now, each system appears to be common, but there was much confusion during construction since the systems were not fully detailed. This forced the CM, Turner-Konover, to essentially act as the designer of record to complete the design of many of the building systems so the project could move forward. The reason for this was the architect's high attrition rate at the time; many talented employees left the firm resulting in an incomplete set of bid and construction documents.

The lack of a viable design resulted in constructability challenges with the exterior wall, MEP systems, and the structural system. The exterior wall was not detailed making it impossible for material selections and finish connections. The MEP and structural drawings were six months behind the architectural drawings and did not match. The design of these systems needed to be finalized and reissued.

Schedule Acceleration:

Schedule acceleration was unnecessary since completion of the design caught up during construction. This resulted in a significant lead for critical path items on the schedule. One example is the construction of the floors, which were two months ahead of schedule. It is possible that an owner initiated change order to redesign the seventh floor would place the project at risk of not meeting substantial completion of 2/20/2009. This is the only area of potential schedule acceleration; the drywall contractor would be forced to work two or three shifts.

Value Engineering:

It is not possible to perform any value engineering tasks on a project that does not have complete design documents; therefore, none of the tasks or suggestions offered on this project to could be considered value engineering. Turner-Konover had spent a lot of time finalizing the design rather than improving the design, which makes Ingleside at King Farm a perfect candidate for studying value engineering.

Problem Identification:

Some of the problem areas identified for Ingleside at King Farm included building envelope performance, building orientation and footprint design, mechanical system design, construction waste management, and water efficient landscaping. An evaluation of each area can potentially improve constructability, accelerate the schedule, and/or add value to the project.

Technical Analysis Methods:

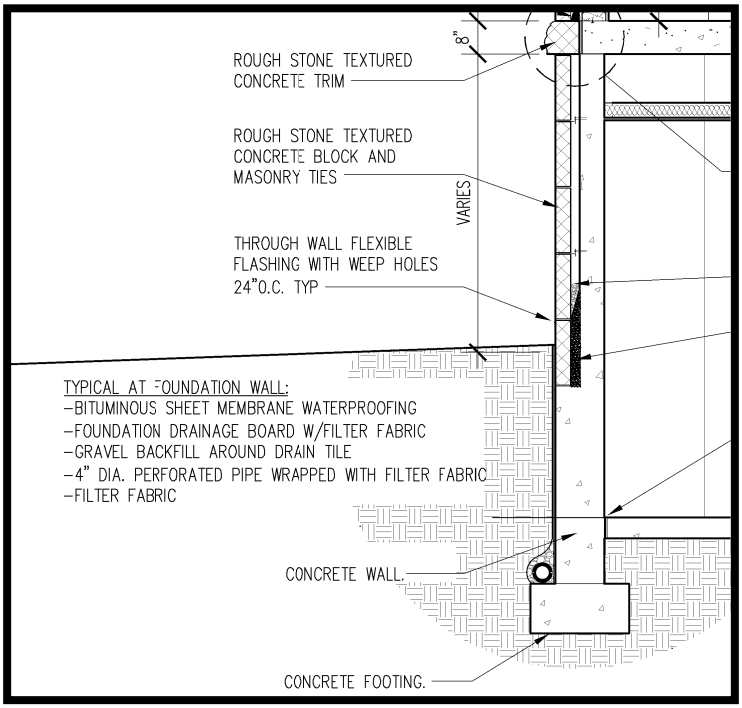
Preliminary methods were developed on four of the five problems areas. The methods include research on alternative products and construction types, implementation of alternative mechanical system design, implementation of a waste management plan, and curb appeal of alternative landscaping. The primary focus of each construction management analysis activity is to improve sustainability of the project as a whole.

Constructability Challenges

Ingleside at King Farm was very challenging because of the lack of design early on in the project. The CSD architecture team is what caused most of the challenges in that they had lost a lot of very talented people with their high attrition rate. This left the owner with a set of incomplete bid documents, which forced Turner-Konover to bid as they saw the project. The following constructability issues all relate to the issues with the bid documents and would have been easily solved if the design had secured a more complete set of drawings. It is estimated that the majority of the design was approximately six months from completion. It was said that there were no difficult pieces of construction for this project, but the lack of complete design documents instructing on what to build is something that will make any project difficult and there were approximately 1,500 RFI's submitted on the project.

Turner-Konover's solution to the difficult problem was to take control of the design by essentially acting as the designer of record on the project to design the systems and hiring their own team of consultants to guide the design of many of the building's systems. The drawings were then submitted back to the architect so they could be officially reissued.

Contractually, this project was delivered as a GMP, but it contained many of the same characteristics as a Design Build project because of the process described above and the nearly two years that Turner-Konover spent finalizing the drawings. All this occurred during construction and was not said to be a major impact on the schedule, although; nearly every package needed to be finalized and the entire design was reissued approximately twenty five times.

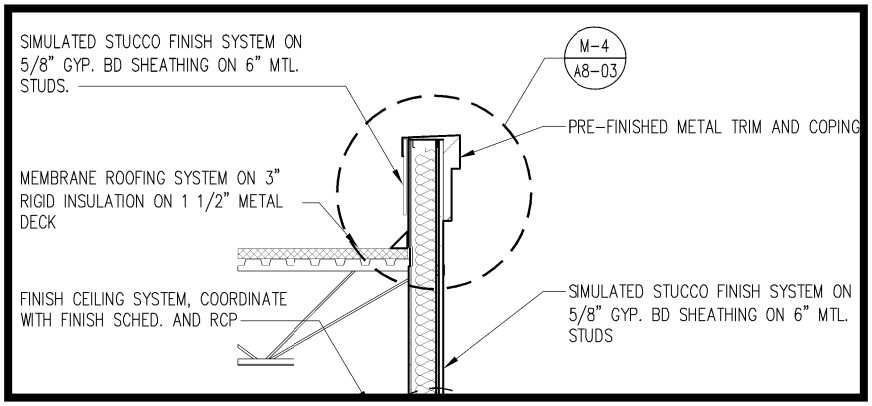


It might not have been perceived as an impact on the schedule throughout the duration since other work could take place while design pieces were finalized, but issues like this can cause major confusion amongst the project team. Each player must be able to read the drawings and know their role in the construction based on the details of the drawings. Ingleside at King Farm lacked some of this crucial detail.

Constructability Issue I-Exterior Wall:

One of the most significant constructability issues at Ingleside is the exterior wall. The issue lies in the lack of a viable design. Explanation of the importance of time spent on design will be touched on in the *Problem Identification* section. The design itself consists

of light gauge metal framing (metal studs) that span between the PT concrete floors. This isn't where the constructability is the issue since it is a simple design in concept, the issue, again, is in the lack of design. As seen in the sketch, the architect was not clear in detailing the features, materials, and connection methods so there were very generic notes on the drawings such as "Concrete Footing." This made it difficult to stay on schedule and forced Turner-Konover, as mentioned, to take the lead on the design. Doing this added approximately $1,000,000 in overall cost to the owner. It also allowed Turner-Konover to avoid delay claims, but it would not have been possible if the owner was not willing to pay for their leadership.



Constructability Issue II-MEP Drawings Mismatch:

The next large issue was that the MEP drawings did not match the. Ingleside at King Farm's architectural drawings were six months ahead of the MEP drawings as a result of Turner-Konover's leadership in completing the design. An issue like this places more stress on construction manager because they're essentially designing the MEP system in the field. Efforts spent on designing take away those that can be spent on constructing.

Constructability Issue III-Structural Drawings Mismatch:

There was another mismatch in drawings; the structural drawings were also mismatched from the architectural drawings. A situation like this is much more stressful than the MEP mismatch issue since a mistake in this area could cause catastrophic failure of the structure. Like the solutions used for the other two constructability issues, the drawings were reviewed in the field by the structural engineer and the structure was adjusted to compensate for the architectural drawings. This issue shows that the structural drawings were not coordinated with the architectural drawings as many other features of this project.

Schedule Acceleration Scenarios

Critical paths are important to follow to complete a project on time. One of the critical path items of this project was the construction of the floors; the structural system that holds the building up. In reviewing this with the project manager, it was stated that the floors finished two months ahead of schedule so it was virtually removed from the critical path. At this point, the MEP related tasks were placed on the critical path.

MEP related tasks became more time-dependent because they were beginning to fall behind due to the lack of design documents. Once these were reissued, the construction was able to "naturally" catch up to schedule so that schedule acceleration was not

required for these tasks. Another reason for not accelerating the schedule was due to the owner initiated changes to the seventh floor, which occurred several times.

Currently, the biggest risk, or obstacle, to substantial completion is the completion of the seventh floor. It's also possible that the owner may initiate another change to the design or layout, which will place the completion of the seventh floor at jeopardy of missing the substantial completion. Substantial completion has already been moved due to the building permit being issued late.

If required, the seventh floor would be the only area where an accelerated schedule would be followed. In particular, the drywall was mentioned to be the most feasible task to implement schedule acceleration on. Turner-Konover would handle it by running multiple shifts (double or triple), rather than allowing over-time. Multiple shifts may cost additionally in labor, but will be less costly than over-time in that the wages will be more near regular-time wages.

Another scenario would be to increase manpower on the project. This would essentially do the same thing as running multiple shifts, but would get it done quicker. Care would need to be taken so the floors do not become too over-crowded. Over-crowded floors will cause trades to interfere with each other and could actually be a counter productive acceleration scenario. A balance between additional shifts and increasing manpower may be the best option to avoid over-time expenses and over-crowding, which should be achievable given the large footprint.

Value Engineering Topics

It was stated that there was no value engineering implemented on this project. The reason for this was that the project was not fully designed and value engineering was not an option with this project without having complete design documents. As mentioned above, it took nearly two years to finalize the design, which left very little time for Turner-Konover to discuss value engineering as the project needed to move forward. In essence, the value engineering took place in an iterative manner in that they were brought up as the systems were developed in the field. Some minor items were discussed that would save the owner money, but these were not discussed during the design phases so they can't technically be considered as value engineering and they were only a small portion of the overall GMP contract value. One of the items suggested by Turner-Konover was an alternative piping, the PEX tubing mentioned in earlier reports, which would save approximately $100,000.

Technically, the idea to achieve LEED certification was not a value engineering idea because it was thought of during the construction process. Achieving this certification, or even deciding to achieve this certification at this stage of project, would not likely save the owner money, but would add value to the overall project. An implementation of the LEED practices early on in the design could have saved the owner money, but waiting to implement the ideas until construction has already begun is likely to cost the owner more money than is necessary. Early implementation is where most owners see the most added value because the process can take a holistic approach.

An interview with project manager revealed that there was not much room for value engineering in this project. Many of the materials chosen were affordable and of good quality already, however; as a result of the situation with the Ingleside at King Farm

project, it is suggested that the owner secures more complete bid documents for future projects. Fortunately for this project, there are sufficient funds and time available to complete the project, but a more detailed plan would save the owner even more time and possibly save more money as well.

Problem Identification

Construction projects are each unique and pose many challenges for designers, managers, and builders since there are a multitude of variables that are entered into the design and construction equation. One of the most powerful or influential variables of any project is time. Too much time spent on any one piece of the project could inhibit completion and cause a project to fall behind schedule. Too little time spent on any one piece of the project sacrifices quality and could potentially blind the project team from realizing significant savings and also cause the owner to miss out on great value engineering suggestions. Owners can often save money by following these suggestions. In addition, builders can cut costs by following a well developed plan. This sums up the challenges presented above by noting that not enough time was spent on developing the bid documents and construction documents up front.

The contents of this section will mainly focus on implementing additional sustainable practices or incorporating additional green features into the project. Through doing so, the goal will be to evaluate how the time spent early on in the building process will ultimately effect schedule and budget. In an effort to spread the word about the importance and value of sustainable practices, this assignment will expectantly inspire new thinking and show how sufficient planning is a worthwhile investment of time. It is frequently dismissed in lieu of traditional, or standard, methods in order to stay ahead of schedule in the early phases of a project. Ingleside at King Farm, like all construction projects, has several features that could benefit from additional planning. Each of the items identified below will need further research and evaluation to determine their feasibility.

Building Envelope Performance:

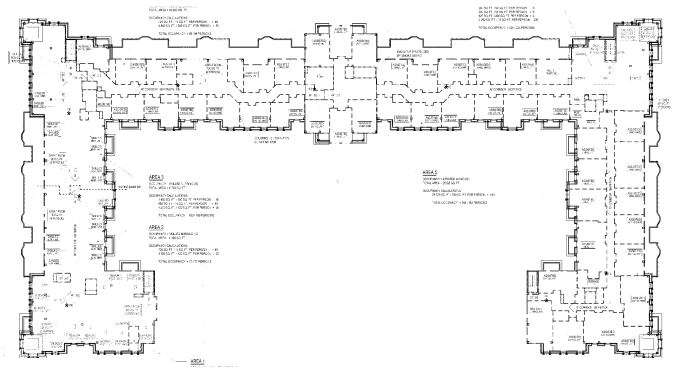
In addition to improving constructability, the thermal conductivity and performance of the exterior wall could be improved by investing in the early design of the building envelope, which would improve the overall building performance as a whole and reduce energy costs to the owner. Increasing the thermal resistivity of the building envelope is almost always a good investment that will reduce operation costs, energy usage, and decrease demand consumption. It is possible that improving insulating properties of the building envelope could be done through changing insulating materials or changing wall construction type. A preliminary suggestion on an alternative wall construction type would be the use of a prefabricated product by Kama Energy Efficient Building Solutions (kama-EEBS).

Kama walls eliminate cold bridges and provide a strong thermal break in the wall system. The product is GreenSpec Listed and Greenguard Indoor Air Quality Certified, which are attributes of its sustainable characteristics. Additionally, the product literature advertises that it can add as many as twenty three LEED points to a project. These are all strong claims that will need careful analysis.

Building Orientation on Site and Building Footprint Design:

Owners are often restricted by setbacks and cost that leave limited options in terms of site layout. This site is fairly large at 11.5 acres so there are more options with such a large area to plan. Ingleside at King Farm is currently in Phase 1 of construction, which consists of one building along the southern edge of the site. Phase 2 and Phase 2A consist of two additional buildings located along the north and east edges of the property. This layout places Phase 1 very close to the edge of the property line and road. Since there are no plans to construct Phase 2 and Phase 2A in the near future, it could be possible to orient the Phase 1 building to maximize southern exposure and reduce northern exposure.

The layout of the building and courtyard offers a welcoming entrance from King Farm Boulevard, but this design also creates more north facing walls and shields some south walls from direct sunlight. This could cause unnecessary moisture problems leading to and mold, moss, and mildew. Alternatively, the design may have more positive impacts in that it shades more residencies from direct sunlight and wind, which will decrease cooling loads in the summer and could decrease heating loads in the winter.



A building's location is equally important as the design of the footprint. Ingleside's site has space to relocate Phase 1 further from the road to reduce excavation costs of and minimize the risk of cave in on the south side if there was adequate space to step the soils back. Exercising this option could increase excavation productivity by reducing cycle times of the dump trucks due to moving the bulk of the work closer to the prime stockpile area. These benefits in conjunction with decreased cost could save a significant amount of money in excavation and save time. Relocating the building further north could even save money and time on civil costs if utilities and infrastructure are more easily accessed from Piccard Drive.

Reorienting the building and redesigning the footprint could be major undertakings. Determining the locality of infrastructure is simple and can be solved by obtaining the proper drawings and calculating a cost difference in civil costs based on a difference in building location, which would lead to an excavation savings estimate based on a different building location on the site. Analyzing the other ideas will require a solar study to show potential heat gain on the southern exposure and shadow lines in the courtyard in reference to current orientation and footprint design. A separate analysis will also need to be done with a proposed orientation and footprint design. The analysis will require a

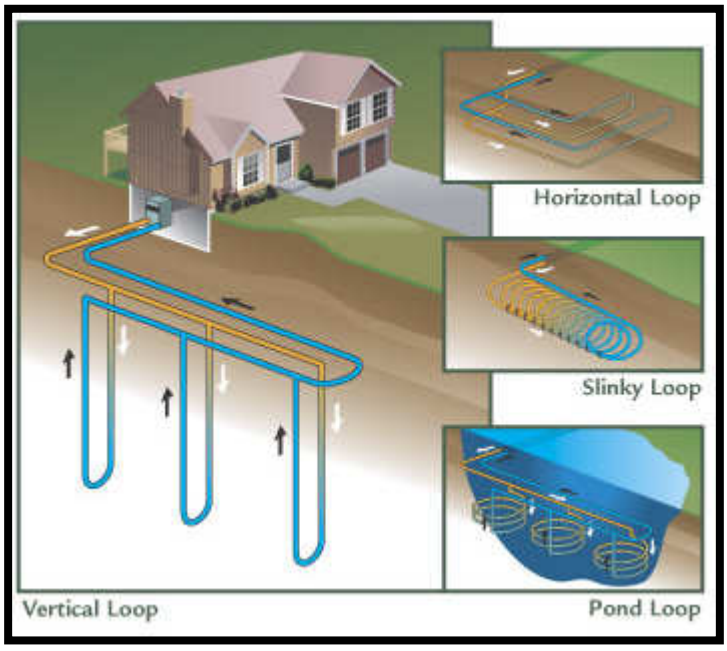
weather study to determine which is more important to mechanical loads in terms of the currently shaded courtyard and the proposed courtyard; the cooling or the heating.

Studying the impacts of the building orientation and building footprint design is not likely to uncover a large time savings in the grand scheme of the project, but may make significant reductions in civil costs and excavation durations, which adds value to the owner. An analysis of these ideas will also potentially uncover significant operations savings for the owner adding more value to the project.

Mechanical Systems Design:

A project like Ingleside at King Farm is complex in the sense that many environments must exist under one roof. This may seem like a perfect situation to use multiple mechanical systems, but by doing so, you are increasing time spent on installation and labor costs. The residents will each have their own heat pump, while the common spaces and corridors are conditioned using a separate system. It is possible to provide the same type of system to serve both spaces, but more research would need to be done on the feasibility and functionality of doings this. One reason Ingleside at King Farm may have been designed to have separate systems for each unit may have been to prevent cross-contamination of occupant germs and illness. If this happened, the Indoor Air Quality (IAQ) would be jeopardized and would detract from the quality of life that the owner desires for its residents. It would also detract from a sustainable and environmentally friendly building.

Another potential "green" feature that Ingleside could take advantage of is integrating the feature pond that is called for in the plans as a water source or heat sink for the water source heat pump system. An example of this "Pond Loop" is shown in the picture. At first glance, the pond appears small to support a mechanical system required for a building of this size, but research could be done to investigate the feasibility of spending some extra money on excavating a deeper pond, or spreading the pond's footprint to increase the water volume of the pond. If feasible, the owner could save thousands of dollars in cooling tower costs and even more money in energy costs throughout the life cycle of the building. If not feasible, investigations into a geothermal system could prove worthwhile and could preserve the open space of the site.



Construction Waste Management:

During a site visit to Ingleside at King Farm, it was evident that construction waste is a big issue with this project. Piles of trash were found in various locations throughout the building due to overflowing dumpsters. Some of the trash piles were large enough to fill a room rendering that area unworkable and blocking trash chutes from being used when dumpsters were empty. This type of issue can cause a safety hazards such as tripping and can slow down a project. Trash is a huge consideration, especially on larger projects. Trash costs money to dispose of and adds considerably to landfills, which existing ones only have twenty years of capacity left in the U.S. based on our current trash generation. This project, although pursuing LEED Certification, did not have an effectively executed waste management plan, which could've gained the project an additional LEED point under credit 2.1.

Water Efficient Landscaping:

Landscaping adds significant curb appeal to a building and helps set the feel for a building. The landscaping is important for creating a quality atmosphere in this continuing care retirement community so sacrificing landscaping is not an option to the owner. Alternative water efficient landscaping is an option, though, that may contribute to the LEED Certification credits. Consideration must be given to the layout and plant type in order not to detract from atmosphere of the community. A recent conversation with the owner's son, who is tracking the LEED documentation, revealed that there have been numerous conversations with the City of Rockville about the potential for achieving this credit. Further investigation into the curb appeal and variety of native species of plants would be required to determine if the proper balance between aesthetics and sustainability could be reached.

Technical Analysis Methods

Although there are many opportunities to address change in the design of a project, not all of the ideas are feasible. Some of them appear to be more achievable than others. This section will focus on four of the problems and challenges addressed in *Problem Identification*. A description of the analysis methods and the type of design and construction analyses will be given along with anticipated research required to analyze the problem or challenge. The four areas of technical analysis will be Building Envelope Performance, Mechanical System Design, Construction Waste Management, and Water Efficient Landscaping. Ideas and research will be further developed at a later time.

Activity I-Building Envelope Performance:

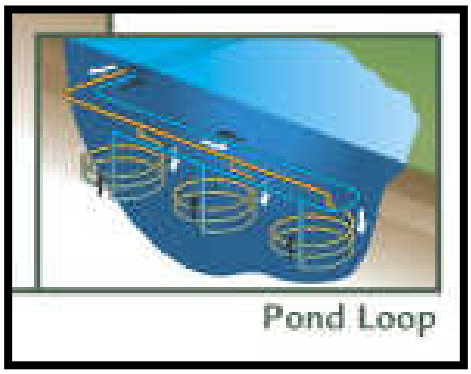
The exterior wall was noted earlier as one of the constructability challenges. It is also an area with room for performance improvement. In order to improve the performance of the system, the first task must be to evaluate and understand the existing design and construction of the system in terms of thermal resistivity. Once this information is understood, the next task will be to research alternative materials such as the kama-EEBS wall and research alternative wall construction types to determine the best fit for the project. These alternatives will be compared against the existing system for energy performance, material cost, labor cost, and duration of construction.

Material costs will be calculated using a detailed cost estimate of the current building envelope and compared to a cost estimate of the proposed kama-EEBS system. Labor calculations will be done based on existing schedule durations to show variance in labor costs between the two systems and impacts that the proposed system might have on project duration. An extra task will include the anticipated LEED points that can be added to the project by using an alternative construction type and it will be compared to the current system.

This proposed system addresses the critical issue of a lack of time to design the exterior skin by the CM. It will also improve constructability, require much less installation time, and prove to be an achievable value engineering idea by potentially adding LEED points.

Activity II-Mechanical System Design:

A study on the reasoning behind separate systems for each residence will be performed to determine if it would acceptable to switch to more centralized units, but to achieve a sufficient level of breadth, it will be assumed that this is not acceptable, therefore, the majority of this construction management analysis will focus on integrating a water source geothermal system into the existing design. The geothermal system would replace one, if not both, of the cooling towers depending on the loads each tower handles. An understanding of the water properties entering the resident's heat pumps will need to be gained. This includes temperature and flow. Next, it will need to be determined if it is possible to connect the piping system to a system fed by an outdoor pond source. This includes research on the separation of treated and untreated water to prevent corrosion of the pipes. If determined to be possible, analysis of the volume of water required to maintain the operation of this large building will be determined. Finally, cost comparison of purchasing cooling towers vs. the cost of additional excavation, piping, and labor will be performed.



An idea like this could contribute to value engineering and decrease first cost. It could also accelerate the schedule because the project would not be relying on a long lead item, but has the risk of holding the project up if the workforce is not experienced with the complexities of the systems. Functionality can be verified through additional commissioning so a cost estimate for this will be developed. Additional effects on the project include improved constructability and reduced costs for the roof structure due to a reduced roof load and eliminating the use of the crane to erect cooling towers.

Activity III-Construction Waste Management:

Implementing construction waste management practices into the Ingleside at King Farm project would not be difficult if well planned. The first task to evaluating this would be to develop an achievable and affordable execution plan that can be shared with workers so they know the plan and understand the importance of following the plan. Additional research will be performed to learn how to achieve buy-in from the project management team and the workers. Next, the required amount of additional dumpsters

will be determined along with pricing for the additional dumpsters so trash can be separated from recyclables. Site impact and logistics will also be considered for the additional dumpsters.

A list of local recyclers will then be created to show where specific materials can be taken and a list of manufacturers offering products with minimal packaging will be provided for commonly used items such as adhesives, fasteners, and insulation. Window, door, equipment, and furnishings manufacturers will also be contacted to inquire about the feasibility of reducing their packaging. It's anticipated that maintaining a clean site could improve productivity, so a schedule comparison will be provided showing the negative impact that trash can have on a schedule. Finally, a cost comparison of how much money that will be saved on tipping fees will be provided and compared to current trash build up, which will reveal an estimated reduction in tonnage saved from landfill waste.

A clear and affordable construction waste management plan will improve site safety. The reduction or elimination in site clutter will improve productivity by reducing loss time due to unworkable areas of the site. If the plan is well developed and achievable, it may uncover significant savings that could potentially be passed on to the owner.

Activity III-Water Efficient Landscaping:

Designing a water efficient landscape, like implementing a construction waste management plan, is not a difficult task if it is properly planned. In order to evaluate this, research on the currently specified plants will be done to determine approximate water consumption requirements. These requirements will be compared to a weather study showing the average expected rainfall for the location, which will determine the amount of additional watering required for the landscaping. This study is likely to show an excess amount of water is required beyond what can be absorbed from expected rainfall.

Reeds

Once the data is revealed, the highest consumers of water will be studied to find opportunities for reducing the amount of that species, removing that species, or replacing that species with a different species. Research on native species of plants will be performed to find alternatives to the currently specified species. The consumption will be recalculated with each alternative species until the consumption falls below the naturally occurring rainfall.

There will likely be a cost difference between the two design solutions, so a cost comparison will be provided primarily on the difference in plant cost. If it is anticipated that there will be a significant difference in labor associated with the alternatives an estimated labor cost will also be provided. There will also likely be a difference in maintenance and operational costs associated with alternative solutions so an estimate of labor and water usage costs will be provided for each. Cost will not be the only consideration for the alternatives.

In order to maintain the curb appeal of the building, a form of survey will be required to determine if alternative species, such as sea grass and reeds, will be acceptable. A survey with a set of side-by-side photos, or renderings, of the landscaped areas can be distributed to poll which alternatives are more pleasing to the eye. If it is determined that the current design is comparable to the alternative, then a study will be performed to determine if additional LEED points can be achieved.

Incorporating a water efficient landscaping plan is anticipated to improve constructability since most alternatives will include native species, which should not require extensive labor to plant. It may accelerate the schedule since native species will be easier to acquire and will have shorter lead times. The alternative landscaping will also add value to the project by saving the owner first cost and lifecycle costs.

Sea Grass