SUSTAINABLE DESIGN OVERVIEW

As part of its original charge to the HSBC, the School Committee requested a facility design that adopts appropriate best practice solutions and considers incremental initial capital costs to reduce long term operating costs. The School Committee also emphasized the quality of the learning environment. The HSBC then further defined its goals regarding environmental responsibility as follows:

ENVIRONMENTAL RESPONSIBILITY

- Optimize interior environmental quality for IAQ and educational performance
- Incorporate green design measures that enhance educational performance or curriculum
- Consider green design measures that produce positive payback on operational costs or that capture additional funding
- Consider other green design measures that are environmentally responsible at an acceptable cost

The design team has provided specifications and preliminary drawings that attempt to accomplish these goals as appropriate for the level of detail reviewed to date. Detailed review of issues such as indoor environmental quality and the impact of many specific materials specified will be researched further in later phases. Similarly, detailed energy efficiency measure payback calculations and other detailed lifecycle cost analysis will be developed as the project proceeds. To date discussions have been centered around large scale decisions that will have major impacts on the level of sustainability of the current design, as well as cost implications, in several key areas:

- Enhancing the learning environment
- Reducing the cost of operations and maintenance
- Minimizing environmental impact of the construction and ongoing operation of the High School facility

There are hundreds of possible upgrades to specific materials and systems that we will consider in more detail in later phases of this project. At this point the preliminary specification, as reflected in the cost estimate, includes site design as well as major building systems and material options that will have a significant improvement on all of the three goals above. We have particularly concentrated on any items that significantly enhance the learning environment or have significant verifiable payback that would lead the Committee at this point to adopt systems or materials that would not fit into the current construction budget despite the fact that they may provide excellent lifecycle-cost-reducing effects.

SITE DESIGN

The existing Wayland High School site is over 77 acres and is has significant environmental limitations as well as resources. A large portion of the site is within wetlands, wetland buffer zones, flood plain, or river protection zones. There are also two public wells on the site which have significant limitations on construction within the 400' radius zone 1 aquifer protection area and the entire site is included in the slightly less restrictive zone 2 area. All of this is to say that the highest level of environmental care is going into the design of the site. Near the wellheads and wetlands only replacement of existing paving is being completed. No expansion of play fields, irrigation, or paving is being contemplated within the well head protection zones or within the wetlands or buffers. The only work being contemplated that will require tradeoffs in flood plain volume in adjacent areas is the raising of the soccer/lacrosse field behind the tennis courts that is too wet to play on for a portion of every spring season. The current design includes raising the elevation of this field by 1'-6" with gravel from the existing site cuts in other locations in order to allow it to drain better in the spring. This work will require grading within the wetland buffers zones as well as providing compensatory flood plain water storage dug out of adjacent upland areas to replace the storage volume lost due to the raised grade of the field.

Plantings are being carefully selected from native species to reduce or eliminate watering requirements as well as provide habitat for local fauna. Deciduous trees will be strategically located to provide shade to the south sides of the buildings during the summer months but allow daylight penetration and the associated solar gain in the heating season. The existing thick top soil, usually over 12" thick and often much thicker, will be maintained on site to allow minimal watering. Only small areas of key athletic fields will be irrigated. Due to the need to store water as part of the water detention system to slow storm water runoff, the design is also providing storage tanks that catch roof runoff. These tanks will be used to provide water for irrigation, reducing well pumping, or if not needed will be allowed to slowly re-infiltrate into the ground. This water may also be considered for toilet flushing to reduce stress on the Wayland water system. Cost effectiveness of this measure will be analyzed in the next phase.

IMPERVIOUS SURFACES

The design team is targeting to minimize impervious surface area in order to enhance storm water re-infiltration into the soil. However, due to the restrictions caused by the close proximity of the well heads, it is not permissible to change regular parking areas to porous materials since this would allow unfiltered storm water with its associated salt, oil, gas, etc., to recharge into the ground directly. Overflow parking for the few times a year that it will be required – the Thanksgiving football game, and large town meetings, will be provided by adding gravel base under 6" of loam at lawn areas. This will reduce costs, impervious area, and provide contingency parking.

The current storm water management system uses best management practices (BMPs) such as hooded catch basins and water quality separators to filter out at least 80% of the total suspended solids in runoff as well as oils and gas. Naturalized surface storm water management will be used whenever possible with water quality bioswales leading to surface detention ponds. This will also allow these features to be used as part of science environmental curriculum on campus.

SEWAGE TREATMENT

Currently there is a traditional title V septic system with a combination of leaching pits and leaching fields. This will be replaced with a modern waste water treatment plant that will treat the sewage from the building to drinking quality standards before it is re-infiltrated into the ground through a leaching system. Both the plant and the leaching fields will be located on the east side of the site to be both in the highest available elevation above the water table as well as far away as possible from the well heads.

ENHANCED LEARNING ENVIRONMENT

DAYLIGHTING

Daylighting has been enhanced in the classroom building by first facing the exterior wall of all major teaching spaces either north or south. To accomplish this the building has been elongated on an east / west axis. This allows us to bring in appropriate amounts of sunlight and from directions that are the most controllable. Approximately 66% of our first floor classroom floor area will be excellently day lit, and nearly 100% on the second floor with the addition of skylights to light the interior half of the rooms. This contrasts with the existing classroom buildings that have adequate daylight levels only on the south side for approximately 5' into the rooms along the window wall. The north/south window orientation eliminates low strafing sunlight that comes with east and west exposures. It also avoids overheating in west facing classrooms that would receive maximum heat gain from sunlight at the same time that cooling loads were peaking from combined student use and solar load. Most classrooms have clerestory windows from 7'-4" to 10'-0" above the floor, allowing light to penetrate deep into the space. High windows have been combined with light shelves on the interior to bounce light up to the ceiling and deeper into the space and eliminate glare at desk height directly inside from the windows. Exterior sun shades have been provided at low vision windows that allow the students to see out and connect to the landscape without introducing large amounts of glare that can make sunlight uncomfortable in classrooms. The vision windows also provide at least two operable windows at a convenient height in each classroom. The Commons and the Gymnasium also have skylights to bring in sunlight more effectively and at a lower cost than additional windows. The skylights will typically be provided with diffuse glazing to spread the sunlight throughout the space instead of adding shafts of glaring light in one area. Motorized blinds will also be provided in spaces where light control is required. Skylights also will be operable to allow excellent cross-ventilation in the space – allowing fresh air to enter operable windows and exit with excess heat out the skylights at roof level. At all of these well day lit locations, daylight dimming strategies will be implemented to allow artificial lights to be dimmed or shut off altogether in response to increasing daylight. These strategies will provide for enhanced daylighting that has shown to increase learning rates, reduce absenteeism, and save energy when coordinated with daylight harvesting.

ACOUSTICS

Regularly occupied spaces will also be provided with improved acoustics through the use of a fully ducted central heating ventilating and air conditioning system, which will significantly reduce motor and fan noise in comparison to the existing buildings. The current unit vent solution depends on motors and fans in each unit vent within the classroom. This is what creates the current 45 – 50 dBa classroom background noise level that makes it difficult for some students to hear the teacher or each other. This HVAC system design will be combined with high noise reduction coefficient ceiling tiles and other acoustic treatments to produce classrooms with a background noise level of between 35 – 40 dBa and reverberation times of under 0.6 seconds.

INDOOR AIR QUALITY (IAQ)

IAQ will be improved significantly over the current facility by providing 15 cubic feet of fresh air per minute (CFM) per person in the general classrooms and 20 CFM in Art and Science rooms (as required by current code). Fresh air intake quality will also be improved by locating intakes a significant distant from exhausts such as the car and bus drop-off area. Materials from carpeting and adhesives to paint will be selected with low or no volatile organic compounds (VOCs). Composite wood materials, where available, will be specified without urea formaldehyde.

DURABLE MATERIALS/SYSTEMS

We have reviewed several areas of materials with the HSBC where a more expensive upgrade in material may provide significant lifecycle cost savings over the life of the facility. In some areas the more durable material has been carried as the base assumption such as the masonry skin on the exterior of the first floor. This brick and concrete masonry unit (CMU) exterior will provide a durable, aesthetically pleasing, and maintenance free surface for generations and is similar in cost to other exterior materials. We also reviewed CMU walls for interior partitions, similar to the current facility, but the Committee determined the additional durability over gypsum wall board surfaces did not warrant the significant incremental cost. We also reviewed EPDM, PVC and modified bitumen roofs as three levels of quality and associated cost in roofing systems. We will provide additional lifecycle cost comparison data during the next design phase but at this time, based on preliminary values, each incremental cost buys a longer lasting product but it is still a toss up whether it is worthwhile to invest more for more durable roofs or simply pay less up front and expect to replace the roofs earlier. Rubber flooring is also proposed in high use areas such as corridors in lieu of vinyl composition tile (VCT) as a material that will cost more initially but eliminates costly regular waxing and stripping and also provide a more durable, longer lasting product.

ENERGY EFFICIENCY

The heating, ventilation and air conditioning system, as well the electrical systems, are the primary energy users on campus. These systems have been specified to include the following upgrades, which, based on our experience with other similar projects, have both short paybacks, and also are incentivised by the local investor owned utility companies, in this case, Keyspan Gas and NSTAR Electric. The systems currently specified and carried in the cost estimate would conservatively be expected to receive rebates from the utility companies toward the incremental cost of these upgrades of between $175,000 and $300,000. Rebates would decrease if any alternative (non-electric or natural gas fuel) were used for heating or cooling. Based on previous HMFH projects we would expect the payback of the entire bundle of utility approved energy efficiency upgrades to be below 4 years without rebates, below 2 years after rebates, and even lower if state reimbursement is included.

- Energy efficiency features in current design that are expected to receive utility incentive rebates:
- Energy efficiency options and cost included in current design:
- Efficient fluorescent lighting, less than 1.2 watts/s.f.
- Multi-level lighting controls
- Daylight dimming where daylight is sufficient – Classrooms, Gym, Commons, Media Center
- Extra light occupancy sensors
- High Performance glazing – low-E double glazed curtain wall and skylights, triple glazed windows
- Extra rigid wall insulation
- 4” (R-14.4) spray-foam icynene insulation in stud cavity (as an add alternate)
- Premium efficiency motors
- Two-speed fan control on large single space air handling units (AHUs) – Commons, Gym
- Variable frequency drives on air handling units

- Expanded Direct Digital Control system with optimized controls
- Controlled outdoor air quantities at AHUs
- Energy recovery in 100% outdoor air units
- Condensing boilers

RENEWABLE ENERGY

Renewable energy systems are typically not considered in Massachusetts public school design because of the assumption that they are unaffordable unless subsidized by outside grant funding. Currently there are not any programs specifically tailored for schools that would provide funding for renewable energy systems such as an earlier Green Schools program funded by Massachusetts Technology Collaborative (MTC). This MTC program provided funding for additional analysis and design, as well as the incremental cost of construction of electricity producing renewable energy systems such as photovoltaic systems, wind turbines or fuel cells. Over the next several years new programs from MTC may be launched that would allow for additional funding in this area. They are currently reviewing options for providing additional design and modeling services even if construction funding is not provided. However, given the relatively low wind speeds in the area none of these technologies would be expected to have a short payback at WHS without grant funding. Some systems, such as solar hot water heating has a better payback but due to the irregular and relatively low domestic hot water use at a school still may not meet the HSBC's threshold for required payback. Wood chip gasification heating systems are the only renewable energy driven system HMFH is aware of that has a high enough payback, 10 years +/-, to be regularly installed without subsidy. They have also been around long enough to have developed a reliable track record of performance. There are wood chip gasification heating systems at over 25 public schools and universities in Vermont and Massachusetts. These types of renewable energy systems may be investigated further in later design phases as a way of reducing operating costs as well as providing both a locally and globally more environmentally sensitive solution to campus energy needs in comparison to the current oil fired boilers.

Renewably energy systems that create energy from free sources such as sunshine also have the obvious advantage of being independent of traditional energy cost fluctuations. Wood chip prices, although not free like sunshine, do have a significantly reduced beta (measure of price fluctuation) compared to fossil fuels, which vary significantly due to geopolitical conditions. This reduced price volatility would make it much easier for the Wayland School Department to predict its annual heating budget. Wood chip costs have averaged approximately half of oil costs per therm over the last 30 years. Providing a majority of the heating energy for the high school renewably rather than using fossil fuels also offers a significant educational opportunity on campus.

LIFECYCLE COST ANALYSIS

We encourage the Town of Wayland, as an owner that will use this new facility for at least 50 years and will bond the construction of the project for 25 - 30 years, to analyze options with a more long-term view point than typical developers. Due to the bonding this type of upgrade would save Wayland taxpayers money every year, not just after 10 years. Many options that are above the typical utility company approved 3 - 5 year payback still make payback sense for an owner that will occupy its buildings for many years. In addition, the fact that the town pays for 100% of the energy cost for as long as it owns the facility but only a portion of the initial construction cost, if state reimbursement is received, makes this proposition that much more palatable. Additionally, if energy costs increase over time, these initiatives will save even more.

Detailed analysis is proposed for several major areas of materials and system selection with significant opportunities for reduced lifecycle cost through reduced energy or water use, systems that are more durable and last longer, or materials that require less maintenance labor or material cost. In the next phase we propose to complete general lifecycle cost analysis of major HVAC system selections and then later on a more detailed analysis of individual energy efficiency features. We also propose to analyze the major materials at the High School that require the majority of investment in maintenance costs, typically labor. For example, we will review various types of flooring that do not require waxing and are more durable as well as roofing systems that last more than twice as long as EPDM. We believe that this type of lifecycle cost analysis will provide the HSBC with the decision making information necessary to promote long term cost effective and environmentally sensitive planning that is important to both Wayland environmentalists interested in facilities lasting longer and requiring less energy, as well as the average tax payer that would simply like a lower tax bill each year.

NEXT STEPS

As part of the next phase of design we will review a number of these types of upgrades that may be modeled to determine what the lifecycle costs of various alternatives are. This will allow the Committee to make decisions based on appropriate payback, cost of money, budget implications, etc. We will assist the Committee in developing a threshold for appropriate payback requirements.