Appendix A - Embodied Carbon

Embodied carbon consists of all the greenhouse gas emissions associated with building construction, including those that arise from extracting, transporting, manufacturing, and installing building materials on site, as well as the operational and end-of-life emissions associated with those materials.

Precise embodied carbon analysis is extremely difficult to complete. For example, you could specify a certain type of brick. However, that brick could be manufactured at two sites in the US, and one location in Canada. Each one of those sites receives their sand and clay from different suppliers. Each supplier receives the sand and clay from different mines. Each mine has different mining practices and therefore different operating carbon profiles. If that's not complicated enough, each of these steps in the process of mining, supplying, manufacturing, and delivering bricks can change throughout the year as market conditions and several industry variable change.

Compounding this challenge is that Massachusetts Procurement Laws require the City of Newton to accept "or equal" materials, equipment, and components. This means that you could complete a Life Cycle Carbon Analysis, LCCA, on the specified components, equipment, and materials, and you may be required to allow for the use of substitutes that have different embodied carbon profiles.

Our approach to reducing our embodied carbon starts at the very beginning of the design process. One way to significantly reduce your embodied carbon is to carefully consider reusing the existing building. In some cases, this is not possible or practical. In cases where your existing building is significantly smaller than the building you need, saving the existing structure may not net a lower carbon footprint. Either way, you'll want to select a design team with the ability to conduct a whole building LCCA. The LCCA should be done when comparing renovation and addition to new construction, but also periodically during the design process to assist in the decision-making process concerning building design, material, and system specifications.

The most effective approach to driving down embodied and operating carbon is to not construct more building than you need. A tight building footprint, efficient floor-to-ceiling heights, minimal circulation space, and ensuring that the space program is not providing more space than is necessary. This is true with new construction, and with a building addition.

Once we've nailed down a spatially efficient design, we can shift our attention to the building materials and specifications.

Concrete, steel, windows, asphalt, and metal panels, are all examples of building materials with high levels of embodied carbon. Depending on the project, using a wood-framed design has less embodied carbon than a steel-framed approach, but this should be weighed against the carbon sequestration reduction that occurs when trees are harvested. Reducing the structural demands of the building can also help drive down

the embodied carbon. When you apply integrated design principles to this the embodied carbon impacts compound. A leaner structure results in a leaner foundation and a leaner earthwork approach. Shorter floor-to-ceiling heights, means the building is shorter, which means that there is less exterior wall area, which means less bricks, metal panels, and other exterior building materials. On the inside of the building, there's less drywall and finishes. With a smaller building volume, the heating and cooling loads are reduced, so the HVAC equipment sizing is reduced. This then reduces the electrical distribution size requirements. It's amazing how relative small design changes can have a profound impact on reducing the embodied and operating carbon footprint. Additionally, these changes help reduce the capital and operating costs. As part of the LCCA report, we include a page that lists all major building systems and material options being considered sorted by embodied and operating carbon. From a macro perspective, this list is very useful in determining where we focus our attention.

The LCCA's are a helpful tool in reducing the carbon footprint for our building projects. These reports not only help highlight the building systems and areas where we should focus our attention, but they can be used for benchmarking purposes both phase to phase within a single project to measure the success of previous efforts, but also as benchmarking data for comparative purposes from one project to another.

While the building design should be the primary focus, site improvements often have a large amount of operating carbon, and a healthy amount of embodied carbon as well. We try and keep our site layouts as efficient as possible to help reduce the amount of site asphalt and concrete, which also helps with stormwater management and heat island impacts. Consider grading in lieu of retaining walls whenever possible and practical. Where possible try and adjust the grading to limit the amount of ramps and railings needed. Even landscape design can help. Drought resistant plantings will limit or eliminate the need for irrigation, which reduces the operating carbon.

Preference should be given to fixtures, furnishings and equipment which inherently have lower embodied carbon content.

Beyond using the LCCA to help guide the embodied carbon decision-making process, we like to list the building material options sorted by embodied carbon for every major building system. This really helps guide the decisions on every design detail as you move through the process.