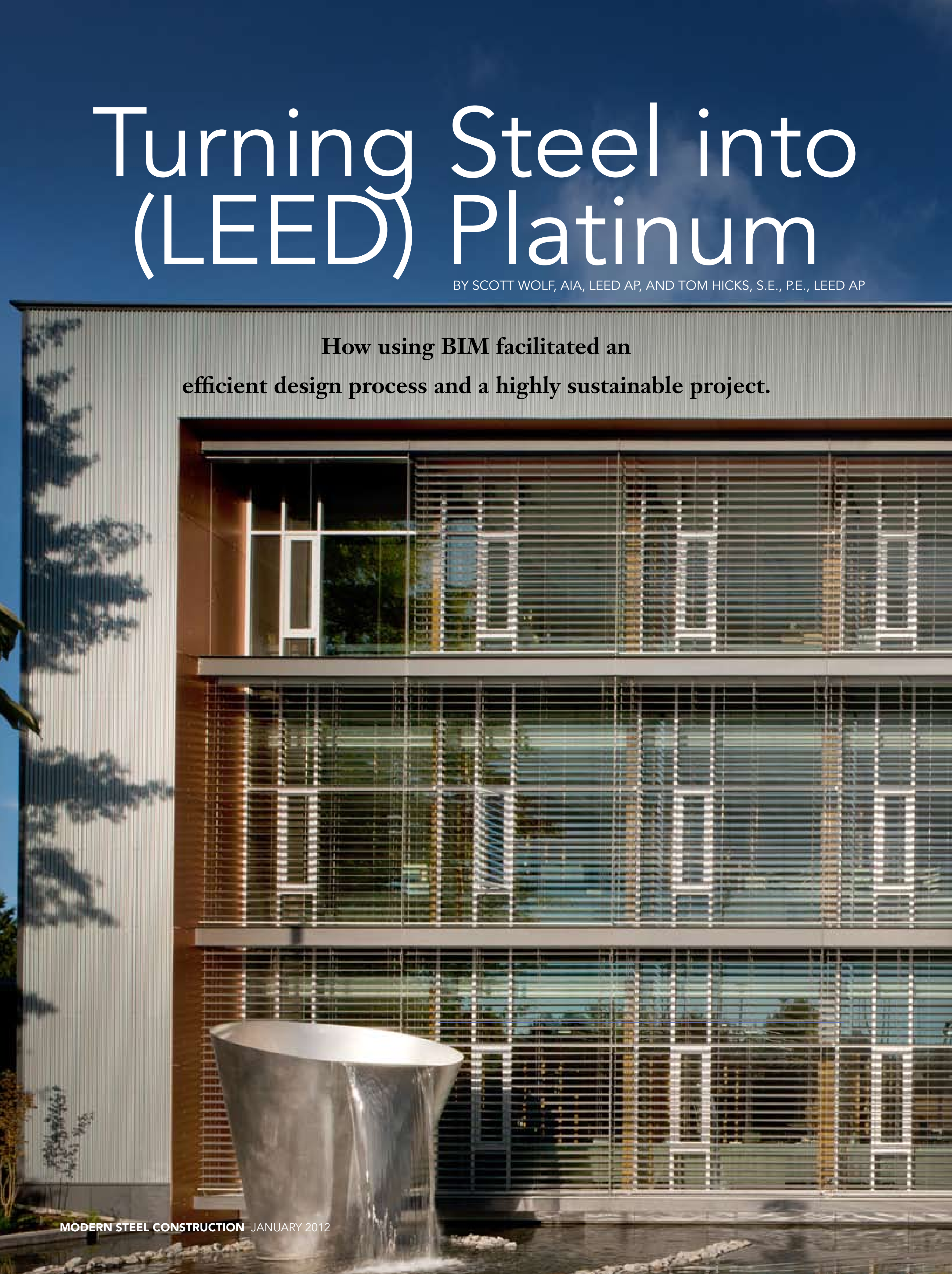
Turning Steel into (LEED) Platinum

BY SCOTT WOLF, AIA, LEED AP, AND TOM HICKS, S.E., P.E., LEED AP

How using BIM facilitated an efficient design process and a highly sustainable project.



Nic Lehoux, courtesy of the Miller Hull Partnership

WHILE MOST WASTEWATER TREATMENT PLANTS around the country are separated from their communities by chain-link fences, LOTT Clean Water Alliance's new Regional Services Center in Olympia, Wash., actively engages the public. The project, which received LEED Platinum certification from the USGBC, includes a 200-seat boardroom, renovated laboratories, an administration tower with offices for LOTT staff and an extensive "WET" Center (Water Educational and Technology Center), which features interactive interpretive exhibits focusing on water resource education and awareness, along with a 50-seat classroom.

The design challenge for the project included renovating the existing 8,000-sq.-ft cast-in-place concrete frame and precast-clad administrative and laboratory building and adding a new 24,000-sq.-ft connected four-story Regional Services Center to house administrative offices, an emergency operations center, boardroom, and an education center with interpretive exhibits and a classroom. Designed with a contemporary, industrial aesthetic, the building complements its surroundings, while the structure's height serves as an iconic civic symbol for the neighborhood. The facility is coordinated with other projects planned in the emerging East Bay Redevelopment area, including a new Hands On Children's Museum and the East Bay Civic Plaza—both currently under construction and also designed by Miller Hull and AHBL—on the immediately adjacent parcels.

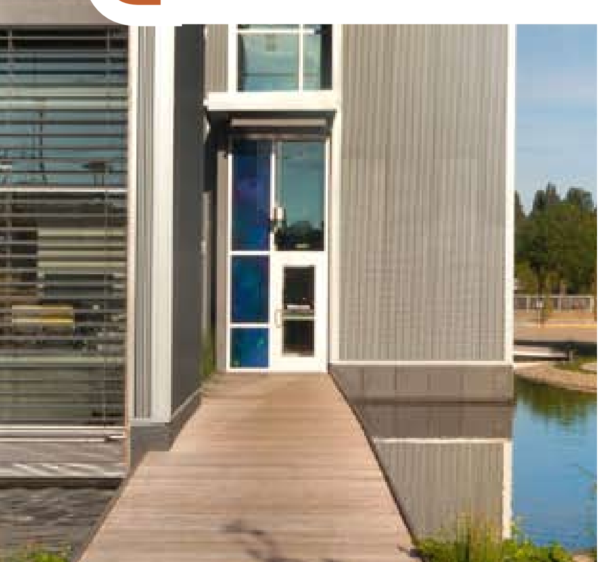
The Structural System

Structurally, the Administrative/Education Center was designed as a main four-story structure, with a single-story, low-roof area interfacing with the second-floor level along the north and east sides. The high and low roofs are framed with steel beam joists supporting a

What is LOTT?

The LOTT Alliance that was formalized in 1976 had its roots in the early 1950s. It consists of four government partners—Lacey, Olympia, Tumwater, and Thurston County (LOTT)—and provides wastewater management services for the urbanized area of north Thurston County. LOTT's wastewater facilities include a central treatment plant, major interceptor sewer lines, pump stations and reclaimed water plants.

Scott Wolf, AIA, LEED AP, is a partner at the Miller Hull Partnership, Seattle, widely recognized as a leader in environmentally responsible design, and recipient of the 2003 AIA National Firm Award. He served as Partner-in-Charge on this project. Tom Hicks, P.E., S.E., LEED AP, is a principal for the structural division of AHBL, Tacoma, Wash., with 20 years professional experience. He has a particular interest in projects involving sustainable design techniques and has worked on more than a dozen LEED-certified projects, including LOTT Clean Water Alliance's Regional Services Center.



The west facade of the four-story office tower features dynamic louvers that adjust throughout the day and control daylight in the offices.

Nic Lehoux, courtesy of the Miller Hull Partnership

Steel frame under construction showing the east end of the project with the one-story structure in the foreground and four-story structure beyond.

welded steel roof deck. The joists are spaced at a maximum of 8 ft on center. The elevated floors are also framed using steel beam joists spaced at a maximum of 8 ft on center; however in this case, the beams are designed to act compositely with the concrete-topped steel floor deck through the use of field-welded headed studs. Columns are primarily square HSS. Lateral loads are resisted by special steel concentrically braced frames, which were also designed as HSS. The primary frame is supported on a pile-supported foundation system, which incorporates a structural slab on grade, grade beams, pile caps, and concrete-filled, driven grout piles extending to 100 ft below the ground floor elevation.

Why Steel Was Chosen

Steel became the logical choice for this project very early in the design. The soil characteristics at this site are such that seismically induced soil liquefaction extends to a significant depth below the building. Once that stratum is penetrated, the soils are generally not suitable for bearing until fairly large depths are achieved. As a result, each pile has a large cost associated with it. The relatively light weight of a steel-framed structure ultimately meant that fewer piles and pile caps were required, thus resulting in a lower foundation cost.

In addition to the choice of steel resulting in a more economical foundation system, steel allowed AHBL the flexibility to meet the architectural design intent, while keeping the structural systems themselves unimposing in the overall design. Where structural framing was exposed in the final design, the architectural and structural designers coordinated all aspects of the layout and appearance. Where items could be concealed within walls and not exposed to view, more economical detailing of elements, such as braced frames and their associated gusset plates, was utilized.

Design Collaboration Using BIM

BIM is revolutionizing how projects are designed, executed and delivered. Both AHBL and Miller Hull are at the forefront of that revolution and are recognized as national leaders in BIM technology. The relatively simple decision to implement the project using BIM had a profound, and in some ways unexpected, impact on the design process.

Without the use of BIM, most projects are modeled using SketchUp in the early design phases. Under this paradigm, the SketchUp model needs to be updated in tandem with AutoCAD drawings as the design progresses. Using this bifurcated methodology it is inevitable that at any given point the SketchUp model might conflict with the AutoCAD drawings. The inefficiencies inherent in this approach are removed when Revit is used from the beginning of schematic design. Implementing BIM from the outset ensured that the model was always synchronized with the design process. This synchronization made the model an integral part of the design process rather than merely a schematic representation of the result.

AHBL used Bentley's RAM Structural Steel software to model and analyze the gravity load-resisting members of the steel frame in addition to generating traditional 2D AutoCAD drawings. The 3D model was shared with the architectural team by using the RAM-Revit link within Revit Structure, and the final drawings were produced using Revit. This created a compatible structural model that the team was able to import into the architectural model. The team was then able to compare the two models to ensure that any exposed steel members were appropriately sized and placed. By sharing the Revit model between the structural engineer and the architect, our team was able to coordinate the location of each exposed structural member to satisfy the desired design intent. Utilizing Ram Structural System in conjunction with Revit ensured that the design satisfied all the structural constraints.

Throughout the design process, our team periodically overlaid BIM models of each building system in order to run clash detections and address physical conflicts virtually before construction began. Add-on programs such as Ecotect, Green Building Studio, Grasshopper and other sustainable design software tools provide early feedback and direction for various sustainable strategies. In essence, utilizing these tools facilitated a highly sustainable coordinated design effort and enabled conflicts that would often be identified in the field during construction, to be discovered in the office well before the contractor had mobilized.

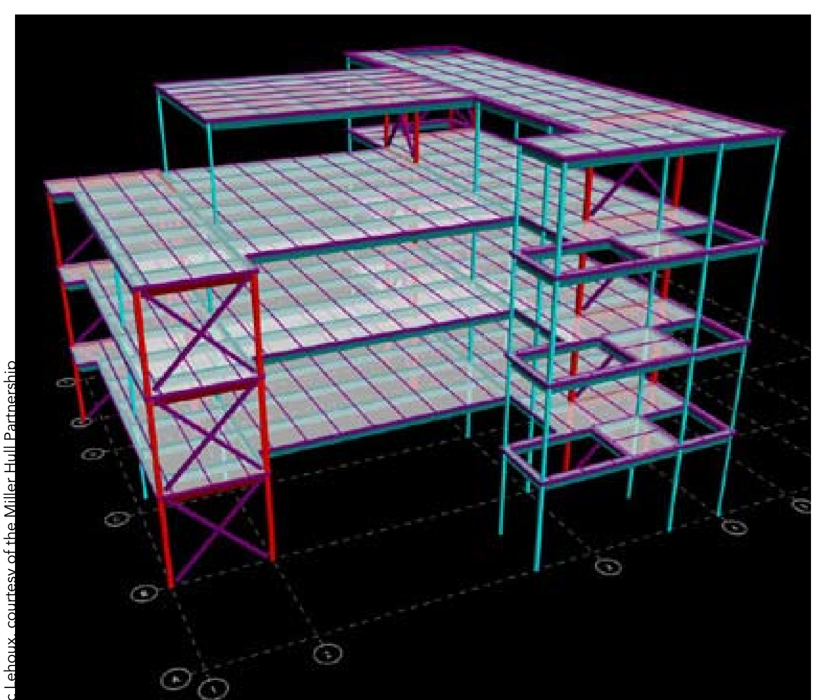
In order to fully engage this opportunity for collaboration we retrofitted one of the office conference rooms into a "Digital Design Lab." In this space we were able to hold weekly meetings where the design team could view the Revit model and discuss pertinent design elements, making necessary changes to the model in real-time. Consultants who were unable to be physically present were able to participate remotely using WebEx technology, a web-based platform that allows them to see the same images that we were seeing on their desktop monitor. This weekly engagement with the model enhanced communication and collaboration between team members. Design ideas were explored and discussed with immediate 3D visual feedback. This degree of collaboration would not have been possible without the use of Revit.

Although the cost and time savings associated with this process change is difficult to quantify, there are unequivocal qualitative benefits. The BIM process enabled our design team to generate a higher quality building that had fewer coordination issues during the construction process.

The Construction Phase

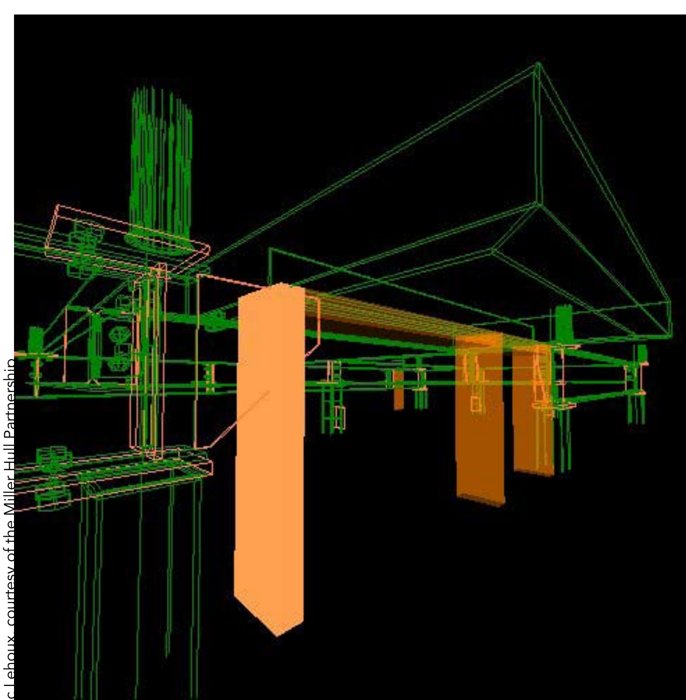
The construction phase of the project—delivered under a traditional design/bid/build method—also benefitted greatly from the use of BIM. The fabricator developed steel shop drawings using StruCAD. By taking the fabricator's BIM model and overlaying it on the design team's BIM model using Navisworks (a program that facilitates the compatibility of different 3D modeling software packages), we were able to run clash detection during shop drawing review and determine areas of conflict that needed resolution before fabrication and erection. Using a graphic model to analyze these conflicts was infinitely quicker than reviewing 2D shop drawings as conflicts or differences became immediately apparent when the models didn't align.

Comments on the steel shop drawings were marked up in the model and conveyed to the detailer to make the necessary revisions before fabrication began. This process saved a significant amount of time for both Miller Hull and AHBL's review process and resulted in fewer field issues during erection than one would encounter on a typical project. As a result of this coordination, conflicts were significantly reduced and the steel erector was able to erect the frame without having to stop and refab pieces or pause for resolution of in-field conflicts.



Nic Lehoux, courtesy of the Miller Hull Partnership

RAM Steel analytical model of the four-story structure taken from the south.



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An example of a Navisworks collision on the south side of the building between steel gussets and the curtain wall head at the fourth floor.

Results/Outcomes

The project has been widely recognized in the design and construction industry, garnering many awards since its August 2010 completion. In addition to receiving LEED Platinum certification and a number of education, infrastructure-related and civic design awards, the project received the prestigious 2011 National Top Ten Award from the American Institute of Architects—a recognition given to the 10 best projects in the country for both sustainable design performance and design excellence. The project also received one of eight Grand Awards presented for Engineering Excellence in the American Council of Engineering Companies annual design competition in recognition of its outstanding engineering achievements.

As a result of using BIM to design and document the steel framing and other key systems on the project, the design team and contractor were able to better coordinate and detect conflicts and issues before they became issues in the field. Our team's commitment to integrated design processes using BIM technology and the resulting level of coordination resulted in a project that enjoyed excellent bid results 18% under estimate, a small number of RFI's at only 32 per $1 million of construction, and a change order rate due to design team errors and omissions of only 1.07%. These figures are well below industry averages and saved the owner a significant amount of money, which could be reallocated to highly impactful exhibits and programs in the WET Center. Although LOTT was the primary beneficiary of our utilization of BIM on this project, both Miller Hull and AHBL are finding similar results on subsequent projects using BIM and are committed to making this method of design and documentation a mainstay of our companies in the future. MSC

Owner
LOTT Clean Water Alliance, Olympia, Wash.

Architect
The Miller Hull Partnership, LLP, Seattle

Structural Engineer
AHBL, Inc., Tacoma, Wash.

Steel Erector
Coastal Steel, Inc., Graham, Wash. (IMPACT Member)

General Contractor
Korsmo Construction, Tacoma, Wash.


The 12 foot high stainless steel "cup" outside the west facade, spills Class A Reclaimed Water into the pond surrounding the front of the building.

The Sustainability Story

Furthering LOTT's mission to "preserve and protect public health and the environment by cleaning and restoring water resources for our communities," the project design includes multiple sustainability stories and those stories were made visible within the building. Due to the regional importance of water and proximity to the Puget Sound, the design process focused on celebrating water as a precious resource. Class A reclaimed water, which this facility produces, is wastewater that has been treated to higher standards of cleanliness and can therefore be used for irrigation, toilet flushing, and industrial and manufacturing uses. LOTT uses reclaimed water for plumbing within the building, as irrigation for the immediate grounds and the building's green roof, and in a highly visible pond surrounding the building. This high-visibility display of reused water highlights LOTT's reclaimed water system, which has been fully operational and in use since 2006.

The building also actively "mines" the adjacent sewage treatment plant, creating an amenity out of what is usually considered waste. Methane gas, a natural byproduct of the wastewater treatment process and 21 times more potent as a greenhouse gas than CO_2, is captured and used in a new cogeneration facility to produce both power and heat, rather than being flared off as a waste product. The energy supplements an existing power loop and completely eliminates power consumption from the grid for the new project. The heat provides additional capacity to an existing low-temperature water loop that provides a heat sink for the new Regional Services Center, eliminating the need for a separate boiler and chiller.

Many recycled or sustainably harvested materials were used in the project, including recycled steel. The project specifications called for the contractor to provide steel products with an average recycled content of not less than 50% (measured by postconsumer recycled content plus one-half of pre-consumer recycled content) and construction waste was recycled at a rate exceeding 95%. Partly as a result of these sustainability measures, the project received a Leadership in Energy and Environmental Design (LEED) Platinum Certification from the United States Green Building Council, earning a total of 59 credits (out of a possible 69) under LEED version 2.2.