EPA REGION 8 HEADQUARTERS: DENVER, COLORADO

The design and construction of the new Environmental Protection Agency (EPA) Region 8 Headquarters in Denver, Colorado illustrates the opportunities and challenges involved in using the lease construction process to deliver a highly sustainable building that meets the tenant agency's extensive requirements.

The developer contract required that the building achieve a LEED Silver certification and an Energy Star[1] rating, and follow EPA's comprehensive procurement guidelines. The design combined age-old strategies for responding to the natural environment with state-of-the-art building systems to reduce energy use by 35% and water use by 40%. The design team went beyond the contract requirements to investigate technologies such as photovoltaic panels, small-scale wind turbines, and a green roof. In addition to the design experts on the development team, GSA and EPA sought advice from EPA's own technical staff, a private sustainability consultant, and agencies such as the National Renewable Energy Laboratory (NREL). The project's prominent site in an urban historic district added another layer of design requirements and stakeholders that needed to be accommodated.

Building designs and team structures evolve over the course of most projects in response to changing demands and external conditions. In an effort to transition this project from conceptual design to an engineered solution, significant changes were proposed to the structural system, mechanical system, and team structure after the development contract was awarded. GSA and EPA had to evaluate the impact of each change, and negotiate with the developer to find a fair agreement that provided good value to the government. This raises issues of how GSA can control changes and define final project performance on leased projects, what type of investment is needed to achieve this level of sustainability, and how developers and the government can work together to their mutual benefit. As Marshall Burton of Opus Northwest, the project's developer says, "Design-build and design excellence should not be mutually exclusive. If excellence in sustainability is a project goal from the beginning, it can be achieved."

[1] Energy Star is an EPA program that rates buildings and equipment according to energy use. For more information, visit http://www.energystar.gov.

Julie Walleisa prepared this case study under the supervision of Professor Spiro N. Pollalis as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation. The author would like to thank Chris Theisen, Mark Pearce, Don Horn and Leslie Galluzzo of GSA, Cathy Berlow and Jim Blackledge of EPA, Marshall Burton, Steve Berlin, JR Reynolds, and Amy Javernick-Will of Opus, John Breshears of ZGF, Kristopher Baker and Rob Bolin of Syska Hennessy, Courtney France of AEC, and Cara Carmichael of Ensar for their assistance in developing this case.

PROJECT INITIATION

EPA's Region 8 Headquarters moved into leased space in the Denver Place building in downtown Denver in 1985, and at that time occupied 180,000sf. Due to the small 12,000rsf floor plate and EPA's expansion over the years, the staff is currently dispersed over 23 floors in two separate towers. In addition, the public underground parking and street parking at the Denver Place building present a security risk, and the building's character does not reinforce EPA's core mission of sustainability. Moving to a new building created the opportunity to consolidate EPA's 850 staff on fewer floors, increase building security, and emphasize sustainability through the building's design, construction, and operations.

While EPA as an agency considers leasing space in existing buildings, they often have to pursue lease build-to-suit construction in order to meet their standards for LEED certification and Energy Star rating. For new construction or major renovations of facilities over 20,000sf, EPA currently requires a minimum of LEED Silver certification, and is considering raising this to require Gold certification. To ensure that EPA's standards would be met in the new building, EPA and GSA worked together to craft a series of very detailed solicitations for offers (SFOs) for the selection of a site and a developer team for the project. They used GSA's boilerplate specifications for lease projects as a starting point. This boilerplate was modified by architects and engineers from GSA and EPA, and EPA created their own program of requirements (POR). According to Chris Theisen, "GSA and EPA had equal input into the SFO."

Selection Process

The first step in the selection process was to identify and secure a site. There are three common ways that sites are provided for federal lease construction projects: a site is donated by the city government, a site is proposed by the developer and evaluated as part of the developer's offer, or the federal government exercises a site option by selecting a site prior to the developer competition. In this case the developer had a site that they proposed, but was rejected based on the fact that it was not central. Since there were few sites of sufficient size in downtown Denver and EPA had specific criteria such as proximity to mass transit, GSA chose to pursue the third option. Site options provide the opportunity to select a site on its merits, independent of the design proposal, and secure this site for later purchase by the developer.

GSA issued an SFO for the project site in 2003, and received offers for 5 sites that met the project criteria. The selected site was owned by Hines Properties and provided 56,773sf of space. The site was located at a prominent intersection in the Lower Downtown (LoDo) Historic District on the 16th Street Mall, a bustling pedestrian avenue, and across the street from Union Station. This provided a prominent location and access to both the 16th Street shuttle and light rail. The site was formerly a post office, and a postal annex that remained on site would need to be demolished for the project to proceed. GSA secured an assignable option to this site for a year at a cost of $12.5M, or approximately $211/sf. This gave GSA

one year to award the project to a developer, who would then be mandated to purchase the assignable option from Hines. GSA had a separate contract with Hines to demolish the postal annex building within 180 days after award. According to Mark Pearce, GSA Contracting Officer, "The site option was feasible because the construction market was so slow at the time. We might not be able to do this in the current market, because there is more competition."[2]

With the site resolved, EPA and GSA were able to move forward with the selection of the development team using a two-stage selection process. The first phase was held in Spring 2004 and evaluated development teams consisting of a real estate developer, an A/E firm, general contractor, and property management firm on the basis of past performance, design and sustainable building experience, security expertise, and financing capacity. Twenty-one developers, including many of the largest national developers, submitted packages for this first stage. Five teams were selected as finalists to move on to the second phase of competition, including Hines with architect William McDonough, Lowe Enterprises with Perkins & Will, Alex Palmer with HOK San Diego, CB Richard Ellis with Fentress Bradburn, and Opus Northwest with Zimmer Gunsul Frasca.[3]

The SFO for the second phase included detailed lease terms, technical specs for architectural, mechanical, and electrical components, and a detailed program of requirements. It required 250,000gsf of space with approximately 231,000sf of office space, 40 secured parking spaces and 70 secured bike spaces, as well as ground-level retail space and a loading dock, with a minimum 25,000sf floorplate. The SFO also detailed numerous requirements and preferences relating to sustainable design and efficiency and established strict terms for achieving LEED and Energy Star certification. The team was required to achieve a minimum of LEED Silver certification within 14 months of reaching 95% occupancy, or risk a penalty of $250,000 annually to be subtracted from the rent. Similarly, the developer was required to provide and maintain an Energy Star rating within 14 months of occupancy, or make changes to achieve the rating and offer the government a rent reduction during noncompliance.

The selection criteria for the second phase, in order of priority, were sustainability (25%), design (20%), workplace (20%), building operations (20%), and price (15%). The SFO directed teams to describe the best practices they would follow for energy conservation, water conservation, resource conservation, and indoor air quality. Developer teams were required to present a complete conceptual design package, including:

- 1/8" floor plans, sections, and elevations, including material notations
- Exterior rendering, site and landscape plan
- Materials board for exterior and common areas and list of core finishes

[2] Interview with Mark Pearce, 4/17/06.
[3] Hines owned the project site selected earlier in the process. Both CB Richard Ellis and Opus Northwest had previously delivered LEED Certified projects for GSA.

- Narrative and basis of design for building systems and how they will meet Energy Star criteria
- LEED scorecard showing at least 33 points and all prerequisites, with narrative explaining how they will be achieved and identifying LEED accredited professionals (APs) on the team
- Construction waste management plan, energy use estimates, water conservation plan, proposal for reuse of materials, and operations and maintenance plan
- Commissioning plan outlines from 3 independent commissioning agents
- Explanation and analysis of how the design meets the criteria, upgrades beyond the SFO standards, compatibility with surrounding uses, massing and fenestration, site characteristics and orientation, how financial considerations impacted the design, human scale, etc.

The second phase called for three sessions in which the selection committee could interact with each of the five finalist teams, as well as a final submittal from each team. The full teams attended the sessions, including the contractor, architect, engineers, LEED consultants, security consultants, and other key team members. The first meeting was a one-hour discussion session, to allow the teams to get a sense of EPA's and GSA's priorities without having to present anything. Each team was given the same information to ensure fair competition, and some teams chose to bring ideas in order to get feedback. The second session was a formal two-hour presentation by each team, and was followed by written comments from EPA and GSA offering feedback on the presentation. Each team then made a final two-hour presentation covering the requirements listed above, and showing a design developed to nearly the level of a complete schematic design. During the process, some of the developers asked for a time extension, but GSA denied these requests to avoid the risk of later protests.

The selection committee consisted of six voting members, from both GSA and EPA. Several other people from EPA and GSA, including GSA's regional chief architect, regional historic preservation officer, and portfolio director, and EPA's regional facility manager and branch chief for sustainability from EPA Headquarters were able to participate in the sessions and provide comments, but could not vote. GSA contracting officer Mark Pearce attended all of the presentations to ensure that the selection process was fair. Cost information was submitted separately to Pearce, who is also responsible for acting as steward for the taxpayers. While Pearce did not vote, he had the power to accept or reject the selection committee's choice.

Because the amount of the prospectus is public information, the developers were able to tune their offers to this limit and all scored similarly on cost. Of the six voting members, five scored the Opus Northwest (Opus) team highest according to the selection criteria. Chris Theisen says: "They offered the most within the prospectus limit – the most sustainability, best security, best understanding of the project needs. Everyone thought the design was very good, and fit well into the historic fabric." Mark Pearce concurs, "They addressed everything we wanted them to."

Each developer team invested a significant amount of time and money in the competition in order to provide the level of detail required by the SFO. Mark Pearce conducted debriefings with the four other finalists, who expressed frustration with the process. He estimates that the teams spent approximately $500,000 each during the process. Opus asked their consultants to price their work at cost initially, with an agreement that they would be paid the remaining amount if the team was selected. Steve Berlin of Opus comments, "I saw the other four finalists present their designs at a DBIA meeting. Three out of four said that they would not do this again, because of the high cost. They only participated because of the slow market at the time." Marshall Burton of Opus adds, "With projects of this scale, it would be possible to pay the four losing finalists a stipend of $100,000 to help defray their costs, and absorb this expense, if this was allowed by the procurement guidelines."[4]

THE TEAM

GSA awarded the development contract to the Opus team in August 2004. Opus's strategy included the formation of a team in which every team member acted as a LEED design consultant. The team consisted of Opus Northwest, LLC as developer, contractor, and owner, Zimmer Gunsul Frasca (ZGF) as architect and LEED expert, Syska Hennessy (Syska) as daylighting, energy, mechanical, electrical, and plumbing engineers, KPFF as structural engineer, and Hinman Consulting as security and blast consultant. Shears Atkins, a local architecture firm with knowledge of LoDo's entitlement and design guidelines, was involved for the entitlement phase. Marshall Burton, Opus's Vice-President of Real Estate Development, says, "We formed the team around the four selection criteria for the project, building in expertise in sustainability, neighborhood context, design, workplace, and economics. The first meeting we had with the team, there was such a constructive, passionate dynamic – I knew we were going to win."[5]

Opus is a national, full-service development company, headquartered in Minneapolis, whose 2005 projects were valued at $1.4 billion. Their staff of 1,100 includes in-house architects, engineers, real estate and development specialists, project managers, and construction personnel. Opus typically acts as architect of record on about two-thirds of their own projects, often acts as structural engineer of record, and performs MEP peer reviews. ZGF is an award-winning architecture firm with offices in Portland, Seattle, Los Angeles, and Washington, DC.[6] Syska Hennessy is an engineering and consulting firm headquartered in New York and Los Angeles, with a staff of over 600.[7] John Breshears of ZGF proposed that Opus bring Syska onto the team, based on their past experience of working together successfully.

[4] Interview with Steve Berlin and Marshall Burton, 4/17/06.
[5] Interview with Marshall Burton, 4/17/06.
[6] Visit http://www.zgf.com.
[7] Visit http://www.syska.com for more information.

EPA put together its own extensive team for the project. EPA's Headquarters in Washington, DC typically manages facility construction projects. The Facilities Management group is responsible for overseeing planning, construction, renovation, and leasing for facilities nationwide. Its Architecture, Engineering and Asset Management Branch (AEAMB) holds the major construction funding and does the majority of project management, while the Sustainable Facilities Practices Branch (SFPB) acts as a consultant to AEAMB. AEAMB typically hires outside consultants for space planning, interior design, furniture design, and move logistics. However, since the project required significant effort to coordinate the building requirements, Region 8 decided to hire a full-time project manager. Jim Blackledge was hired through Region 8's facilities office to manage the local activities for design, construction, and occupancy. Together, Jim and the team members from EPA's national office reviewed drawings and specifications throughout the project. Cathy Berlow from the SFPB says, "It is important to have an EPA representative at the table to ensure that EPA's requirements are not lost throughout the entire design and construction process." Although this project has many competing priorities, Blackledge says, "As project manager, my prime mission is to complete the project. There are always modifiers like schedule, budget, security, sustainability, and local requirements. My job is to push it forward and make sure the project gets done."[8]

Blackledge put together internal teams on a volunteer basis to make decisions on many aspects of the project. For example, a team of ten EPA staff did market research and environmental evaluation in order to make recommendations for furniture, weighing decisions such as wheatboard versus urea formaldehyde-free composite wood. EPA made a mockup of the Herman Miller workstation in their existing office to solicit reactions from the staff. The staff has responded positively to the workstation size and materials, as well as to the planned environmental benefits of the new building. EPA is also pursuing sustainability beyond the scale of the building by trying to reduce their reliance on paper and implementing an electronic equipment recycling program. EPA hired Metropolitan Architects and Planners (MAP) to help create the program and act as design architect for the tenant improvements (TI) work.

EPA often hires expert sustainability consultants to act as technical advisors. Cathy Berlow hired consulting firm AEC to review the SFO language prior to the start of the project, and planned to engage a consultant as technical advisor and peer reviewer for the duration of the project. During the competition phase, AEC was proposed as the LEED consultant for four out of five of the finalist teams. In fact, the only developer that did not have AEC on their team was Opus. EPA could not contract with AEC while there was a possibility that they might be part of the team. When Opus was selected as developer, Cathy Berlow initiated the process of hiring AEC as EPA's consultant. However, AEC informed Berlow that they might be hired by Opus to perform building commissioning, presenting another possible conflict. While TestMarc was eventually selected to perform commissioning, EPA did not want to wait for this decision to hire a consultant. EPA hired Boulder-based Ensar to serve as EPA's consultant, based on their past

[8] Interview with Jim Blackledge, 4/18/06.

work, reputation with the US Green Building Council (USGBC), and team resumes. Ensar's role was to act as technical advisor to EPA's national office, providing reviews of LEED status, energy analysis, etc. throughout design and construction. Ensar's staff communicated through Cathy Berlow, who passed their peer review comments on to the team, but did not communicate directly with anyone else on the team.

Although ZGF was presented as architect and main LEED/sustainability strategist during the competition phase, Opus modified this arrangement soon after award. Opus decfided to use their in-house resources to become architect of record, and hired AEC to produce the LEED documentation. ZGF was fairly involved in design development, and their involvement tapered off quickly in the construction documents phase. Opus and AEC had previously collaborated on a Department of Transportation facility for GSA, which achieved LEED Silver certification. AEC's role is to lead the certification effort, including drawing and specification review, bid instruction review, direction and review of LEED submittals to collect data, and creating the certification application. AEC communicates with EPA through Opus, and with the rest of the team by email. Immediately after award, the team began a series of biweekly meetings to address design issues. While the specific participants in each meeting depended on the agenda, the meetings included participants from the local EPA, EPA headquarters, GSA, Opus, ZGF, and Syska Hennessy.

DESIGN

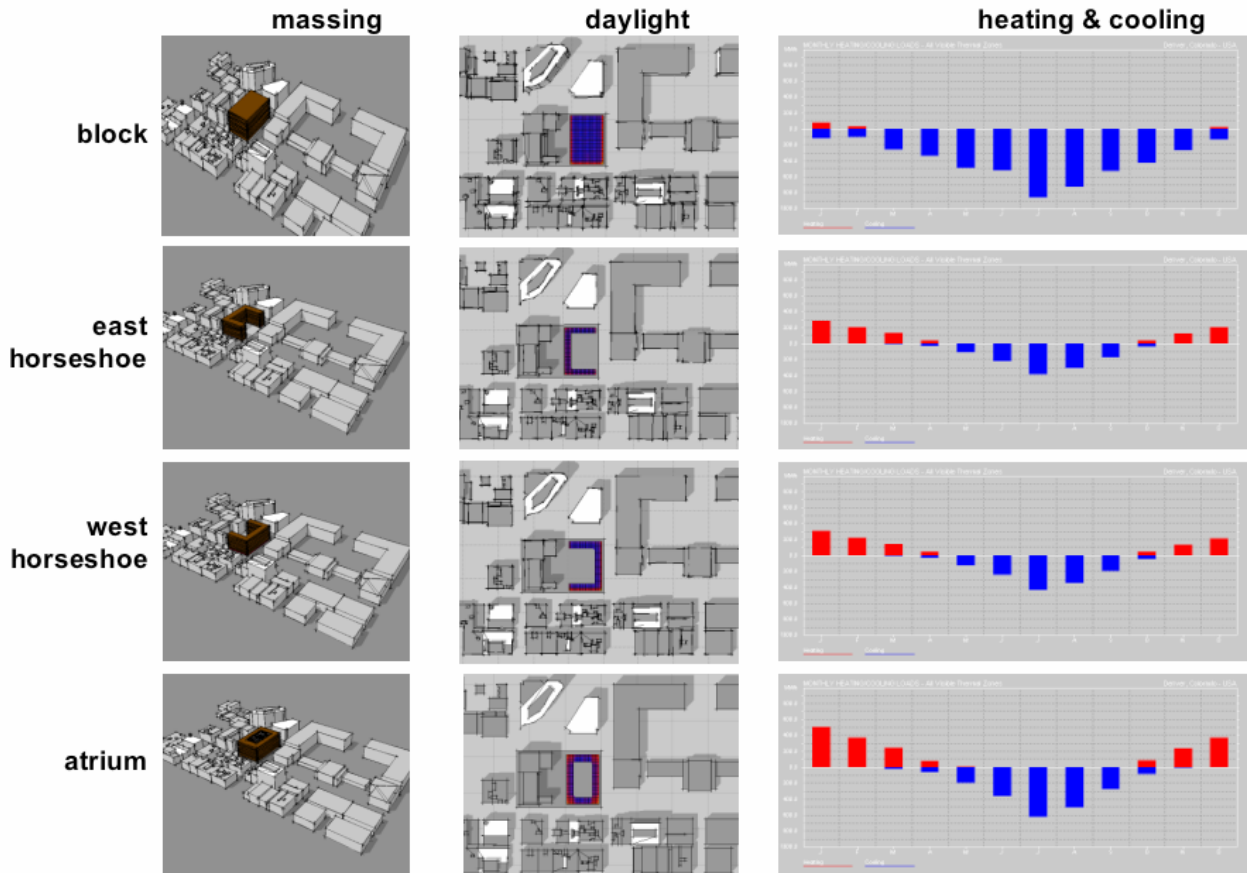
The site offered several opportunities and constraints that shaped the design of the building. It is a prominent corner site in a pedestrian-friendly historic district, across from a future public plaza. In addition to the typical zoning code restrictions on overall building height and setbacks, the team had to address the requirements and concerns of the Lower Downtown (LoDo) Design Review Board concerning paving patterns, street furniture, cornice heights, and fenestration detailing. The urban setting required full buildout to the sidewalk and commercial and retail space on the ground floor, both of which had to be reconciled with GSA's requirements for setbacks. In addition, there was a desire to somehow reflect the local pattern of a mid-block break, with alleys bisecting blocks, even though the building would take up an entire block. Because the building was leased rather than government-owned, there was little leeway in meeting these local requirements.

The design team began by studying several massing options, all of which were 9 stories high and approximately 250,000sf and had the same proportions of brick and glass for the exterior skin. Four massing options were modeled using Ecotect software[9] to create rough energy calculations including heating and cooling per month. A sample level was also studied to examine daylight distribution across the floorplate. A matrix of the results of these studies showed the advantages and disadvantages of each massing scheme, but no clear winner. One scheme included an atrium, which would respond to the

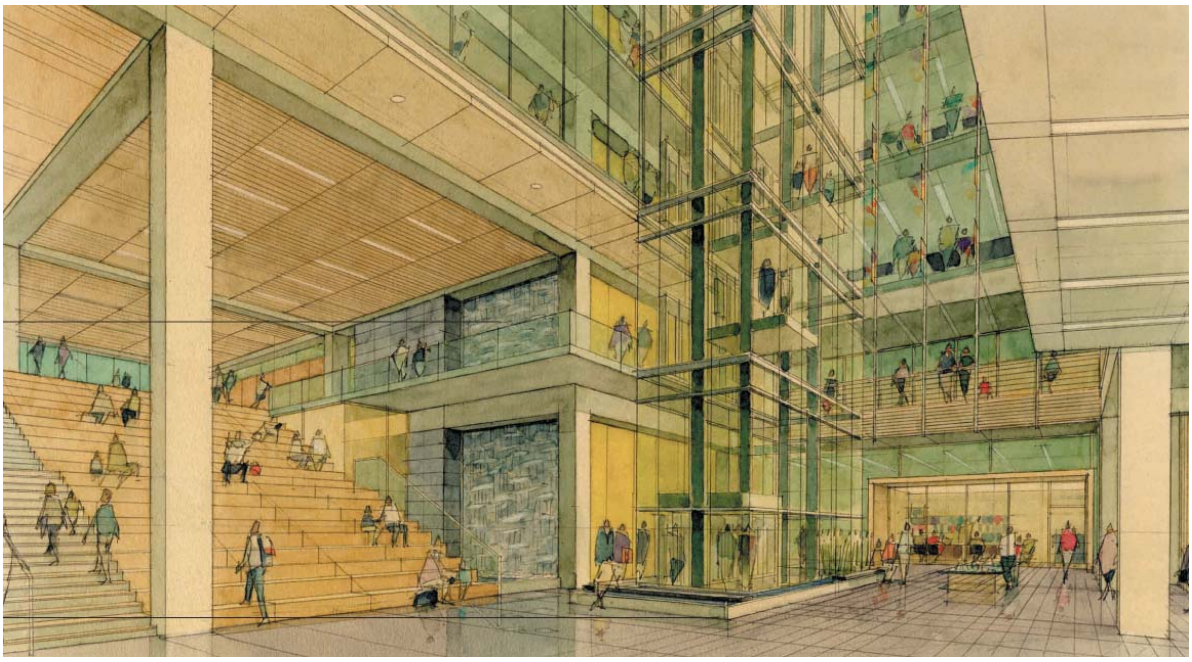
[9] Ecotect concentrates on the initial design phase by coupling a 3D interface with tools for lighting and energy analysis. The basic models created in Ecotect can be exported for uses with more advanced programs such as Radiance or EnergyPlus. For more information visit http://www.squ1.com.

programmatic desire to accommodate EPA's all-hands meeting of 900 staff, while letting daylight into the center of the building. While other schemes had lower projected energy use, the atrium scheme was considered to offer the best combination of energy efficiency and daylighting.[10]

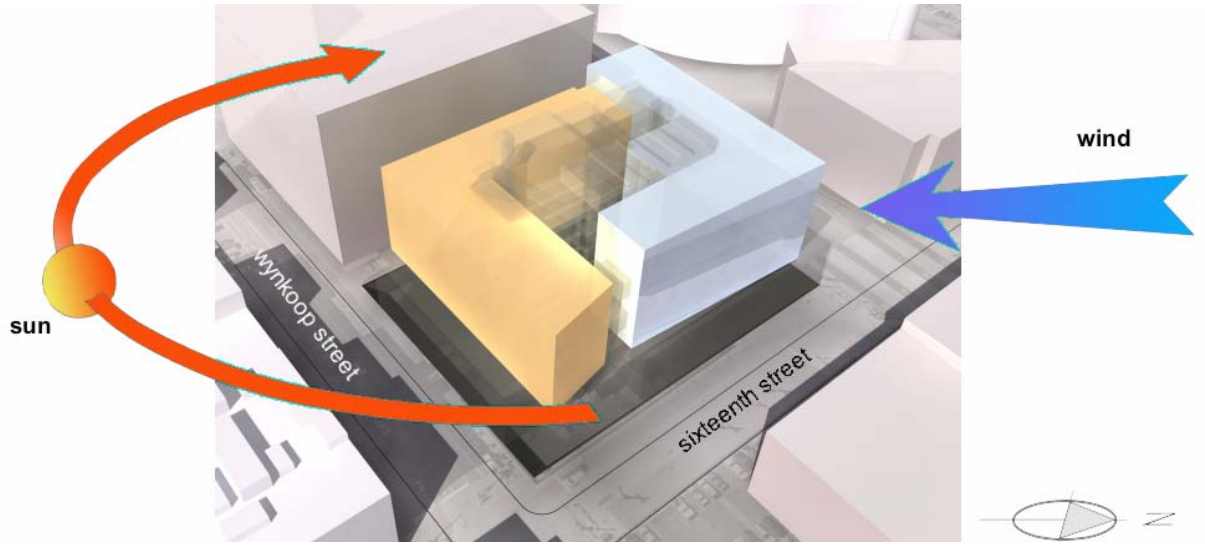
With this basic concept of a square building surrounding an internal atrium in place, the team started looking more closely at the site and environmental influences. The street grid in LoDo is rotated 45 degrees to the compass directions, which daylighting designer Kris Baker calls "the most difficult condition for daylighting." To address this and the prevailing winds from the north, the concept evolved into two differently articulated L shapes wrapping an atrium. John Breshears of ZGF says, "The southeast and southwest legs were designed to deal with the daylight and solar gain, while the northeast and northwest legs were designed for wind. The north leg is nine stories and the south leg eight, to allow for a roof garden on the south leg that is sheltered from the wind. At ground level, a break between the L's creates a corner entry facing the new plaza at Union Station." Responding to the historic context and EPA's desires, the building's glass upper stories rise out of a brick base, with detailing and cornices that respect the surroundings.



[10] Phone interview with John Breshears, 4/7/06.



Rendering showing atrium lobby with seating, water feature, glass elevators, and EPA display area



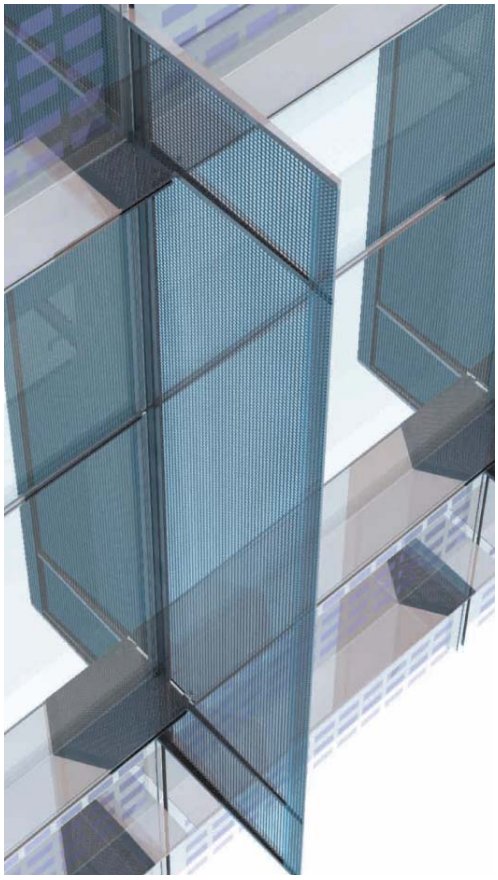
Top: Diagram of double L configuration

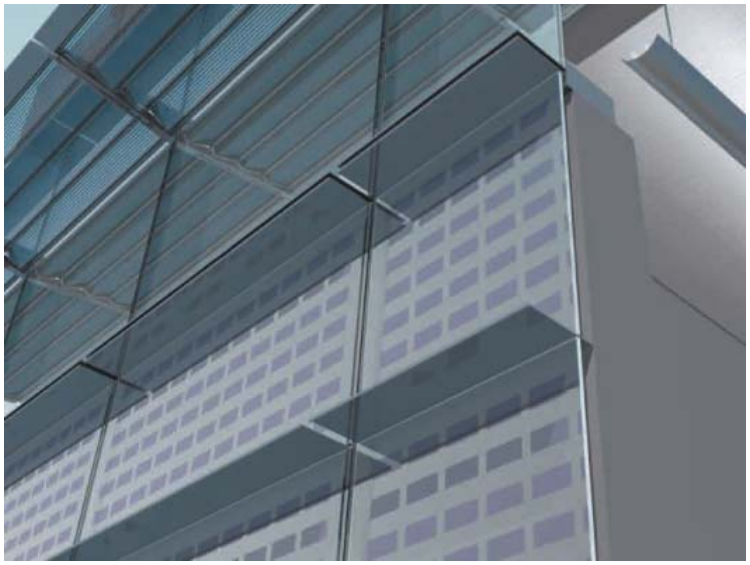
The curtain wall design was modified for each façade with an emphasis on responding to environmental conditions while managing the cost of the system. According to John Breshears, “Cost issues were prominent during design; we were always very aware that this was a developer building.” One example of the team’s effort to balance sustainability and construction cost is the evolution of the exterior sunshades. Both the team and EPA were concerned about enhancing daylight, preventing solar gain, and controlling low-angle glare in the early morning and late afternoon. In addition, they needed to balance the desired performance with construction cost and blast security. The original design called for 36” deep horizontal

shades on the south facades, and 36” deep vertical fins on the north facades. Hinman, the security and blast consultant, recommended that the shades and fins be changed from fritted laminated glass to perforated metal, to perform better in the event of a blast. Syska performed energy and daylight studies to reduce the depth, and therefore the cost, of the shades and fins. As a result, the horizontal shades were reduced to a depth of 20” and the fins to 11”. The interior light shelves on the south facades were also studied to see if they could be removed without compromising the daylight performance, but were left in the design. ZGF used both an Ecotect model and a physical model to study these issues, and passed these models to Syska Henessy for further study, in an unusually direct collaboration process.

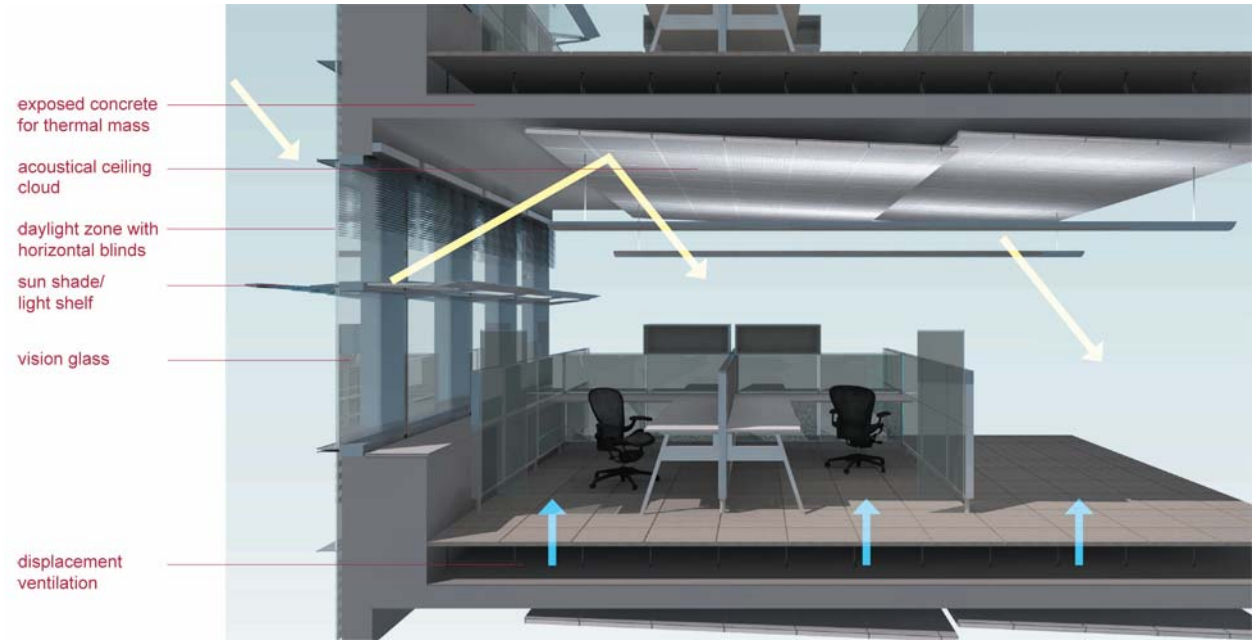
Left, above: Renderings of the final design

Although daylighting was a main focus of the concept, a daylighting designer did not join the team until after award, when the design was largely established. According to Kris Baker of Syska, “The biggest concern for this project is control of direct sun above the light shelf on the south facades, due to the building rotation.” Automatic blinds above the light shelf provide ideal control of daylight throughout the year. Occupants can control the manual blinds located below the light shelf. JR Reynolds of Opus expressed concern that the building may be overly bright at the perimeter due to the selection of clear glass. Kris Baker explains, “Any sidelit daylighting scheme would have more light at the perimeter, but the light shelf helps with this. The reductions in the shade and fin depths have reduced the effectiveness, but not threatened performance.”





Left: Vertical fin, perforated design
Above: Horizontal shades
Below: Sectional diagram showing the daylighting system and underfloor air system



SUSTAINABILITY

The SFO outlined detailed requirements for the design, building materials, and construction and reporting procedures. The team was required to register the project with USGBC during design development, provide an updated LEED scorecard and energy calculations at each phase, and provide plans for final

commissioning, indoor air quality (IAQ), and construction waste management (CWM) at the completion of construction documents. During construction, they had to provide information on the volatile organic compound (VOC) levels for all interior finishes, a monthly CWM report, commissioning reports, documentation on certified wood, EPA Green report documentation, monthly construction photos, and quarterly reports on recycled content. Upon construction completion, the team will be required to provide final LEED documentation, final CWM reports, a final operations plan, a test report on drinking water, a final report on IAQ testing, and a final commissioning report. After occupancy, the developer will have to submit annual reports on recycling operations and quarterly energy use reports, and GSA will have read-only access to a graphical user interface for data collection.[11]

Although the SFO requires that the building achieve LEED Silver certification, the team is hoping to achieve Gold certification. Opus's best and final offer projected the possibility of achieving Gold, in the spirit of achieving as many credits as possible that were compatible with the design intentions. During the selection process, having more points was looked upon favorably. According to LEED consultant Courtney France, "This building is far above the standard of most Silver buildings. The key difference is the commitment of the contractor in dealing with the material credits. Also, the construction waste management is the most aggressively tracked on any project I've experienced. They are even recycling drywall, by providing it to a farmer for use as a soil amendment."[12] The February 2006 LEED scorecard showed 44 points as likely to be achieved, with 4 additional points that may be achieved. This places the project in a good position to achieve Gold, since the minimum for Gold certification is 39 points. Energy modeling using AHRAE 90.1 predicts a 35.7% energy savings, which will earn 5 LEED points. Water calculations predict a 49% savings based on the plumbing fixture selections, which will earn 2 LEED points for water efficiency, and an additional point for an innovation credit.

LEED credits for light pollution and 100% water-efficient landscaping were not achievable due to 16th Street mall requirements for the use of particular streetlights and street trees. However, Opus's design will meet the credit requirements for light pollution and 50% water efficiency for the building's green roof. During the competition phase, the Opus team proposed strategies for incorporating photovoltaics and wind power into the building, but didn't include these in the base offer. Even though photovoltaics have not performed as well as expected in the Arraj courthouse project, the desire to use them at the EPA headquarters has for obvious reasons been much stronger. Building integrated photovoltaic panels were proposed as the spandrel panels within the curtain wall system on the south-facing facades. Since funding for the panels was not secured by the time the curtain wall package had to be released, and the vertical placement reduced the efficiency of the panels, they were removed from the facades. EPA plans to eventually locate a 10-12kw rack-mounted photovoltaic system on the southeast corner of the 9th floor.

[11] From the Building Solicitation for Offers SFO-03-054, March 16, 2004.
[12] Interview with Courtney France, 4/18/06.

Opus may only install the anchor points initially at its own cost, and EPA will install the photovoltaics at a later date. $40,000 have been secured so far, but another $60,000 are needed to fund the system.

The Opus team also suggested the installation of wind turbines on the roof of the northern L, under an airfoil canopy. Wind power was the focus of local interest: the governor had declared a wind power day, and the local utility was trying to position Colorado as the third-largest wind power producer in the US.[13] The team evaluated several horizontal- and vertical- axis turbines, and selected a vertical-axis model from a Finnish company that was designed for use in an urban environment. While the vertical models are less efficient, the use of a horizontal propeller on an occupied roof garden posed a concern. EPA asked the National Renewable Energy Laboratory (NREL) to assess the opportunities and concerns of the wind turbines, using grant funding from the Federal Energy Management Program. The main concerns were that little was known about the effectiveness of wind turbines in urban environments, since most studies were based on open areas, and it was unclear how noise and vibration would affect the building. The team and NREL thought the project offered an interesting opportunity to test a single turbine in an urban setting, on a heavy concrete building, and to determine whether the airfoil would enhance or detract from the wind generation. Due to the uncertainty and lack of funding, wind power is no longer being pursued, but the structural system was designed to support the turbines if funding becomes available in the future.

The building's roof is an EPDM membrane with a high-emissivity acrylic coating. While there are white membrane roofs available that meet LEED requirements, Opus has found that the coating holds up better and is preferred by the roofing companies that provide the roof warranty. The idea of having a green, vegetated roof on part of the roof surface was discussed from the beginning. The design team originally proposed a conventional built-up roof with plantings on top, but Opus's construction personnel expressed concerns about leaks, and how leaks could be found and addressed with this system. JR Reynolds states "The green roof is important here, but my first priority is to have a water-tight building." The built-up system was changed to a modular system[14] to alleviate this concern and allow for easier maintenance. This system consists of 4" deep plastic trays in modules of 2'x2' or 2'x4' that sit on top of the roof membrane. The trays are attached to each other, not to the roof, so no roof penetrations are required. Some changes were made to the roof assembly to accommodate this system, and this resulted in additional costs. The membrane was changed from 60ml to 90ml, a fleece protection mat was added to protect the membrane from friction, and the warranty was extended from 10 to 15 years. The modular system requires trim around the edges, and rubber pavers at the perimeter for use by window washers.

The modules will be planted with a few varieties of sedum. Lacking precedents, EPA was unsure of whether the plantings would survive without irrigation. Opus planted a modular test bed of sedum on top

[13] Phone interview with John Breshears, 4/7/06.
[14] The specified product is GreenGrid. For more information visit http://www.greengridroofs.com.

of one of the construction trailers in Fall 2005. While Opus is providing the baseline 4" system planted with sedums, EPA is interested in experimenting further with the system and has asked Opus for 5,000sf within the roof garden to experiment with other types of plants.

The green roof relates primarily to the LEED credit for avoiding heat islands, but the team has done extensive work to have it apply to the storm water management credit as well. While some cities consider roof gardens to be a best practice for storm water management, there are no precedents in Denver. USGBC does not list this strategy as a method for achieving this credit, but since their suggestions are based on EPA data, the team solicited support from experts including an EPA expert in green roof research, an urban drainage and flood control manager, and the head of Portland's green roof program. This expert data was used to convince USGBC and the city of Denver to allow the roof to serve as an experimental best management practice for storm water management. Since the entire roof area contributes toward the LEED credit for heat islands, the green roof was sized to meet the requirements of the storm water credit, at 19,200sf.

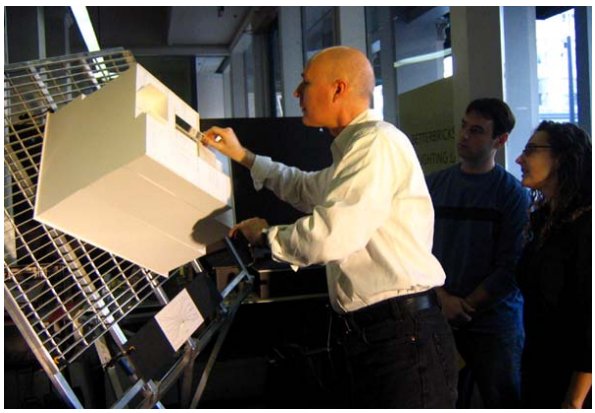
System originally proposed

Photo of test roof on construction trailer

The original design of the atrium roof was a series of shallow peaks, but the design team explored several options to determine how best to direct light down to the bottom of the atrium while protecting the upper levels from heat and glare. During the competition phase, the team quickly designed a faceted reflector on the roof, to ensure that some cost for a reflector would be carried in the construction budget. ZGF built a physical model of the atrium, and of different reflector options, and studied these using the heliodon[15] at the University of Oregon's energy studies lab. Inspired by the array of parabolic faces on the reflector grid from a light fixture, which in testing increased the brightness and uniformity of illumination in the model,

[15] A heliodon is a tool for the visualization and calculation of solar effects at the window, building, or site scale. It creates the correct grometrical relationship between a scale model and a representation of the sun, and typically can be adjusted for season, time of day, and site location.

ZGF started developing a concept of a C-shaped piece of fabric, curved around 2 sides of each of the 15 cells. ZGF studied this in the Ecotect software, which confirmed the effectiveness of this scheme. ZGF first went to tensile companies for fabrication, but their bids came in very high, and there were concerns that the elastic in the fabric would degrade from solar radiation. ZGF then approach Portland-area sailmakers about fabricating the sails, and a Denver-based theatrical rigging company for information on installation and maintenance. ZGF printed a cutting pattern from their computer model, which the sailmaker used to create a scale model (below). The bids for fabrication and installation from these two sources came in within the allowable budget, allowing the sails to remain in the project.



Above: Physical prototype of a sail
Top right: Digital rendering of the sail array at the top of the atrium
Right:Testing the atrium daylighting using a physical model.

DESIGN CHANGES

Given the complexity of the design requirements, EPA and GSA were committed from the beginning to having several people review the project milestones and provide technical advice. In addition to EPA's own regional and national staff and GSA's project staff, each agency hired additional consultants to advise the team. EPA hired Ensar, as described above, to act as a peer reviewer for sustainability issues. Beginning in the design phase, GSA hired Jacobs to act as their agent, for a fee of approximately $200,000. They were hired through a national IDIQ contract, with task orders for site visits, reviews of the schedule and labor wage rates, and other tasks. Jacobs reviewed the milestone drawings and provided cost estimates, including cost comparisons that played a role in negotiations over proposed changes. During construction, Jacobs reviewed the schedule, conducted onsite inspections, and provided reports to GSA.

HVAC System

The building's mechanical system was designed for energy efficiency and increased ventilation effectiveness. The Opus team originally proposed a system based on having two air-handling units per floor, with water-side economizers.[16] This was based on the team's understanding that the system needed to meet the standards of the P100, which requires that air-handling units be no larger than 25,000cfm. According to Chris Theisen, GSA project manager, "Nothing in the lease tied the building to the P100 for mechanical standards. This is only required for government-owned buildings. GSA has the option to use this for lease projects but didn't do that here." Shortly after award, the Opus team proposed changing the system from two air handlers per floor with water-side economizer, to centralized rooftop air handling units with air-side economizers.[17] According to Rob Bolin, "The Denver climate is reasonable enough to use outside air for a fair number of hours throughout the year. Since air can be delivered at higher temperatures with an under floor air system, free cooling with outdoor air can be used for even more hours than normal. However, very large ducts and shafts are needed to take outside air throughout the building. Because the original design would require large mechanical rooms on each floor for the floor-by-floor air handlers, it was not feasible to take up more floor space and reduce leasable area to accommodate these ducts and shafts."

In the final design, cooling is provided by a chilled water distribution system with variable-speed chillers and centralized roof top air-handling units with air-side economizers. On the office floors, air is delivered through an underfloor air system, while the first three levels have conventional overhead delivery to better deal with the variable loads and higher peak loads of this type of use. District steam from the local utility is used to generate heating hot water and domestic hot water, so there are no boilers in the building. An energy recovery system pre-cools or preheats the ventilation air, depending on the season, to save energy year-round. A DDC building automation system controls the HVAC and lighting systems. Lighting is designed to meet the P100 light levels, and includes daylight dimming and occupancy sensors.

While some projects operate both air-side and water-side economizers, the team's analysis showed better energy savings and indoor air quality using only the air-side economizer and limited savings in operating both economizers simultaneously.[18] There are advantages and disadvantages to both the original and final systems. The small floor-by-floor air handlers allow for more flexibility and efficient after-hours operation. However, air-side economizers could not be included unless the air handlers were moved to the corners of the building, which is difficult to reconcile with most space plans. The revised system was presented as equal in energy efficiency to the original design, with improved indoor air quality

[16] A water-side economizer uses condenser water from the cooling tower circuit passing through a heat exchanger to cool supply air rather than operating the chiller. This is possible when outdoor air conditions are suitable.
[17] An air-side economizer reduces the use of the chilled water system by bringing in additional outside air, above the minimum required for ventilation, when the outside temperature is favorable. In the cooling season, up to 100% outside air can be brought in for "free" cooling instead of using the chiller.
[18] Phone interview with Rob Bolin, 5/26/06

due to the increased supply of fresh outdoor air. GSA estimated the revised system would save Opus around $800,000-$1M due to savings in equipment, controls, piping, and valves. An inadvertent omission in Syska's original energy simulations, made during the competition phase, complicated the discussions of energy savings. Rob Bolin explains, "The base case ASHRAE model used for comparison of several systems should have included an air-side economizer, but this was inadvertently left out. Due to this omission, the energy savings of the original scheme were overestimated. It took a great team effort to develop a system that, when modeled, resulted in an equivalent energy performance to that presented during the competition."

Structural & Ceiling Systems

The design for the concrete structure shown in Opus's best and final offer was based on a post-tensioned flat slab with expressed beams on a 5' module. The concrete structure was highly visible in the atrium and overhead on the floors, since the proposed ceiling consisted of floating "clouds" of ceiling tile to expose the thermal mass and take advantage of the thermal flywheel effect.[19] This structure scored high during the competition phase due to its flexibility and shallow depth, which helped maximize floor-to-floor height within the overall height limit for the building.[20]

While reviewing the 50% drawing submittal, GSA and Jacobs noticed that both the structural system and ceiling design had been changed.[21] The structure was now concrete pan joists, which required additional depth (depth varies from 25" to 29" in the final design) and changed the module of the expressed beams. The pan joist system would allow the use of an efficient reusable form system, which would save construction time.

Construction photo of structural system

The floating "clouds" of ceiling tile were changed to a continuous grid system, with tiles placed only in certain locations. While the ceiling remained higher at the perimeter to enhance daylighting and allow return air back into the ceiling plenum, the appearance was significantly different. The ceiling change was proposed to avoid having to provide twice as many fire sprinklers, above and below

[19] Exposed high-mass materials can store heat during the daytime and release it at night, helping to moderate normal daily temperature swings.
[20] Interview with Chris Theisen and Mark Pearce, 4/17/06.
[21] Ibid.

the clouds, which would add significant cost. GSA and EPA objected to the ceiling change, based on appearance and on the fact that the TI design was based on the cloud layout, and the ceiling was changed back to the original design.

The structural change required a good deal more discussion and negotiations. According to EPA PM Jim Blackledge, "Opus presented the structural change as having two benefits: cost savings and time savings. The three goals for the region have always been security, sustainability, and schedule. So, the change fit with our priorities."[22] Since Opus did not quantify the financial or time savings, and did not adjust the construction schedule, it was left to EPA and GSA to determine the value of this change and negotiate an agreement. EPA was willing to sacrifice some of the original system's flexibility in exchange for other benefits. On behalf of GSA, Jacobs performed a cost comparison of the two systems, and spoke with other construction companies, determining that the system change would save about $1/sf, or $250,000 total. GSA and EPA negotiated with Opus for additional tenant space, from an area which had been left vacant for future expansion, in exchange for approving the structural change. GSA performed an analysis based on BOMA rates and past experience in the Denver market to determine the amount of space that would equal the value of the change, and issued Supplemental Lease Agreement (SLA) #1 approving this change in exchange for approximately 17,000sf of additional space.

One risk assumed by the developer was the extent of changes that might be required by the LoDo Review Board. GSA invited LoDo to participate in the selection process, but the board preferred to wait until the end of the process to become involved. The contract stated that the developer would have to meet the requirements of zoning and LoDo at no additional cost. LoDo required Opus to fill in the open corner entry, in order to better frame the corner. They also required changes to the cornice, the height of the brick, and the detailing of the window openings, which were made at Opus's cost.

WORK WITH STAKEHOLDERS

A few elements of the design, particularly the proposed water-efficiency measures, required the cooperation of local agencies like the Department of Health and the Wastewater Management Division. The city and county of Denver required a stormwater management plan to capture large-volume deluges and release the water at a controlled rate, and to perform some limited quality treatment including first flush treatment. ZGF initially wanted to express the movement of stormwater through the building, and explored features such as vertical bioswales, with water cascading down through the atrium planters. They also proposed using waterless urinals and other conserving fixtures within the building.

Colorado has incredibly complex water rights laws, in which water rights are often owned by people downstream, rather than by the owner of the property on which the rain falls. Because of this, stormwater

[22] Interview with Jim Blackledge, 4/18/06.

can only pass through the building one time before being directed back into the system. This allowed detention, but not retention, strategies, and limited the possibilities of strategies such as graywater reuse. The team needed to provide convincing data on the performance of the green roof to persuade the city to waive the requirements for detention and stormwater treatment. In addition, EPA agreed to monitor the results for runoff rate and quantity for 5 years and share the data with the city.

The Department of Health objected to the use of stormwater in the atrium, and to the use of waterless urinals. The team decided to abandon their proposal for the atrium, and instead create a simple atrium water feature using recirculated water. This revised design provides aesthetic benefits, but is no longer a sustainable feature. The Department of Health had previously banned waterless urinals based on a past negative experience, but this ban was overturned for a project at the University of Denver College of Law, for which Ensar was a team member. The Opus team was successful in mitigating the Department's concerns about waterless urinals by obtaining an administrative modification that included future commitments to modify the waterless urinals in case of performance failure.

While the team was able to work effectively with the local stakeholders, there are some issues that might have benefited from early discussions. Courtney France of AEC provided one example, saying, "What could we have done differently? We could have formed an agreement with the City of Denver on city-specific issues such as the city light fixtures and street trees up front. These fixtures and trees are not compatible with LEED requirements, and there might have been a better possibility."

SCHEDULE

The SFO established dates for construction completion and occupancy, and liquidated damages of $15,000 per day if the building is not available for occupancy on schedule. GSA has no control over the schedule beyond those terms. During construction, Opus has been sending GSA updated schedules every two weeks. The occupancy date was changed from July 2006 to October 12, 2006 under SLA #1 due to a delay in the availability of the site. Hines was required to demolish the postal annex building by February 2005, but the building proved more difficult to demolish than expected. They struggled with the heavily reinforced construction, and with taking down a wall along 16th Street without stopping the RTD bus line. Hines had to work around the bus schedule to demolish that wall on Sunday nights, which delayed completion. GSA's site option contract with Hines set the deadline for demolition completion, but did not include any penalty for delays.

Opus asked that the occupancy date be changed from October 12 to November 1, 2006, as a result of the change in the HVAC system that Opus initiated, but this agreement has not yet been finalized. Opus has also asked for an extension to December 15, 2006 due to the increase in the scope of EPA's TI work, which has not yet been approved.

FINANCIAL

GSA signed a 10-year firm lease with Opus, at a cost of $32.22/rsf or approximately $7,452,600 per year. This fully serviced lease includes maintenance, utilities, taxes, etc. There are no recent lease build-to-suit projects in downtown Denver to provide a comparison rate, but Mark Pearce estimates that market rate for a fully serviced lease is about $24-25/rsf, and for class A space possibly $26-28/rsf. Although EPA's rent at their current facility is only $22.18/rsf, GSA considers this rate to be reasonable, considering the prime location, security features, LEED certification, class A office space, and new construction built to order with full tenant improvements.

The maximum term of the lease and lease rate are fixed by the Congressional appropriation. According to Chris Theisen, "We would have preferred to do a 15- or 20-year firm lease, but the scoring wouldn't allow for that." Any desired features that would exceed this lease rate must be paid for separately and fully funded up front, rather than being rolled into the lease rate, to avoid exceeding the rental prospectus limit. EPA planned from the beginning to provide an RWA (reimbursable work authorization) to upgrade the interior finishes. EPA will fund about $3-4M in extra TI funding for upgrades for lighting, carpet, wall treatments, and other components which were not included in the SFO.

Under the project's structure, GSA and EPA do not review any invoices or financials other than the TI breakdown and costs for specific work authorizations for requested changes. The costs in the original offer were just broken into core, TI, taxes, and operating costs. The contract requires Opus to competitively bid every item in the TI scope, but not to share the cost information. Since the building core-and-shell is not funded by GSA or EPA, these components are not required to be competitively bid. EPA is planning to spend $7M on TI with additional RWA funds. The TI include upgrades to blinds, lighting, sound masking, PV anchors, doors, finishes, etc.

The SFO terms included an annual penalty equal to a $250,000 rent reduction if the building does not become LEED certified. Without any precedent to guide them, EPA proposed this number in an attempt to impose a significant penalty, without deterring developers from bidding. Contracting office Mark Pearce says, "While $250,000 may sound like a lot, it is not much compared to the total cost of the lease. If we did this again, I'd try to raise this amount."[23] On the other hand, Marshall Burton of Opus states, "We have always been comfortable that we would be able to achieve LEED Silver, so we are not very concerned about the penalty. The penalty is not small – it has a capitalized value of about $3.5M. But the penalty does not give the motivation to deliver Silver or Gold – that motivation comes from our commitment to excellence."[24] Whether it delivers Sliver or Gold, Opus will get the same amount of rent. According to

[23] Interview with Mark Pearce and Chris Theisen, 4/17/06.
[24] Interview with Marshall Burton and Steve Berlin, 4/17/06.

Cathy Berlow, GSA is currently reviewing these SFO terms and considering increasing the value of the penalty for future projects.

Opus estimates that the total project cost approximately $90M, including 16,000sf of retail space, parking, expansion space, and the $12.5M site cost. The construction cost for the core and shell for the whole building is approximately $50M, and the cost of the TI buildout has not yet been finalized. Marshall Burton believes that “the cost of security was quite high due to the tremendous cost of blast-hardening the glass and concrete.” Reynolds estimates that concrete structure costs would typically be $16-20/sf, and that the cost of hardening and progressive collapse on this project resulted in an upcharge of $10-12/sf. The curtain wall, including the integral sunshades, cost an average of $78/sf across the different types, including the less expensive curtain wall at the retail areas.

Opus has not tracked sustainability costs for this project. According to JR Reynolds, “There is no value for us to spend time doing this on this particular project, since this building is not replicable. A typical 3-story office building might be worth tracking, to provide historical data for estimating costs of future buildings.” Nevertheless, he believes that the costs of security and sustainability for this project are almost equal. The green roof system cost $12/sf installed, with planting, plus another $2/sf for the pavers and trim. Opus hired TestMarc to perform both basic and advanced building commissioning. Their contract includes basic services at a fee of $195,000, plus additional services, for a total of approximately $250,000. AEC’s fee for LEED services is approximately $60,000, including daylight and view analysis and LEED documentation.

CONCLUSIONS

While the team anticipates that this project will meet its sustainability goals and provide an excellent environment for EPA, the project’s structure and ambitious goals led to some challenges and missed opportunities. This project raises the issue of how to determine whether changes due to the evolution of the design and project team are reasonable, and to what extent GSA and the developer can mitigate these changes. During the competition, ZGF was introduced as the architect and main LEED strategist, but after award Opus assumed the role of architect of record and hired AEC to prepare the LEED documentation, limiting ZGF’s involvement. This raises concerns about continuity of design and knowledge in the project. The structural and mechanical systems were also changed after award, resulting in significant potential cost savings for Opus. Chris Theisen says, “This swapping happens all the time on lease projects. The developer offers the top of the line, then after award, proposes switching out the systems. We should be compensated for that.” GSA and the tenant agency need to reach consensus on which changes are acceptable and which need to be prevented, in order to successfully negotiate with the developer.

Since the team and major systems are selection factors, these changes also raise the question of when changes become so significant that, if proposed initially, they would have changed the developer's score during the competition. However, as Marshall Burton says, "Awards are made at a conceptual level. There needs to be flexibility for the systems to change once you start engineering them."[25] GSA and EPA believe that the changes approved on this project meet the project requirements, and that the negotiation process resulted in good value to the government. Chris Theisen believes that including stronger terms in the SFO could have prevented the team changes. Cathy Berlow adds, "I'd like to control the team member swapping next time, but unfortunately legal interpretation can vary between lawyers. I would like to find new SFO language that cannot be interpreted differently."[26]

Opus agrees that modifications to the SFO, and better alignment between the SFO and the procurement process, would alleviate complications for both GSA and the developer. While government awards are increasingly tending towards a design-build philosophy, Opus believes that GSA's contract administration philosophy is still rooted in the design-bid-build structure. Marshall Burton says, "The government should have a different approach to lease construction than for federal construction. They should allow us to do what is best for the project, within the requirements of the performance specification, with less intervention." The current SFO structure also dissuades the developer from exceeding SFO requirements by requiring compensation for the government for system changes, but including no equivalent value exchange for developer-performed enhancements to the project. For example, Opus modified the design to include an increased ceiling height, larger security zone, glass mailroom, and a segregated loading dock with additional dock overhead doors. According to Marshall Burton, the cost of these items, and other building enhancements provided by the developer, were assumed by Opus with no opportunity to participate in a modified form of value exchange with the government.

While cost to the developer and value to the government are key motivators behind changes, the evaluation of changes also involves issues of philosophy and trust. The SFO requirements are largely performance-based, with some prescriptive terms. This played a role in the evaluation of the mechanical system change, since some team members felt that they had to accept any system that met the basic performance requirements. The SFO required LEED Silver certification, which is performance-based, but did not prescribe exactly how this was to be accomplished. It included a LEED scorecard showing EPA's preferences for which LEED credits should be pursued, but no real way to enforce this preference. Opus is proud of the fact that they offered an estimated 37 LEED points at the time of their best and final offer, and are now targeting 44 points. However, there have been questions about whether they should be required to deliver those specific 37 points, rather than the overall performance goal.

[25] Interview with Marshall Burton, 4/17/06.
[26] Phone interview with Cathy Berlow, 5/11/06.

There is risk on both sides of a performance-based contract. While GSA and EPA assumed the risk of items that were not strictly controlled in the contract, Opus assumed risk on unknowns such as the level of changes required by LoDo, and the site contamination. For example, GSA's option to negotiate the land purchase prior to developer selection required Opus to commit to contract terms beyond its control. When soil contamination was discovered on the site, the government-negotiated contract and accelerated closing schedule allowed Opus no recourse with the landowner, resulting in increases in onsite costs for the project.

Given the complexity and sophistication of the building, EPA and GSA tried to limit their risk by assembling knowledgeable internal teams and hiring outside experts to provide technical advice. EPA relied on Ensar to fill in information gaps by offering suggestions of products and strategies to consider in the absence of answers from the team. While this structure seems to have worked well, Cathy Below says, "EPA hired Ensar for LEED/sustainable design review but was asked at times to supply LEED/design guidance to the Opus team during the design development phase. GSA and EPA should not have to provide this service when the contract requires that the developer have a LEED expert on their team." GSA used Jacobs to compare the construction documents to the contract requirements, and judge the value of changes.

In spite of the expertise within the design team and the government's team, some lessons came too late to be applied to the project. Cathy Berlow says, "We considered using demountable partitions for interior walls, but the project was too far along to consider this change. The partition module was different from the module for stud walls, and we didn't want to redo the floor plans at that stage." Similarly, the competition phase did not provide the opportunity to fully investigate multiple daylighting schemes, and yet the chosen scheme became such an integral element of the building that alterations were difficult. Kris Baker says, "The amount of work completed prior to award made it difficult to fully investigate alternate daylighting schemes. In addition to the flat shelf, I would have liked to explore the use of soft sails or translucent tilted triangles that may have worked with the building rotation." The term of the lease, which was established based on scoring issues, impacted the building's sustainability as well. Rob Bolin, formerly of Syska Hennessy, says "A 10-year lease is an unusual thing. A longer lease term would allow for a higher initial investment with a longer payback period. Some design strategies were not pursued because of this limitation." These issues illustrate how important timing is in the formation of a team and in the evaluation of strategies on a project pursuing this level of sustainable design.

APPENDIX A LEED RATING SYSTEM

LEED (Leadership in Energy and Environmental Design) is a green building rating system that was developed by the US Green Building Council (USGBC).[27] USGBC is a national, non-profit organization consisting of members such as architecture and engineering firms, contractors, manufacturers, and building owners. USGBC was formed in 1993, and the first LEED rating system was released in 1998. LEED began as a single rating system, known as LEED for New Construction and Major Renovations (LEED-NC). LEED offers third-party certification of a project's sustainable characteristics based on a review of project documentation. LEED certification is required for many city, state, and federal projects, and is considered by many private developers and institutions to carry a marketing benefit.

USGBC has since created a few other LEED rating systems for specific project types, including LEED for Core and Shell (LEED-CS), LEED for Commercial Interiors (LEED-CI), LEED for Existing Buildings (LEED-EB), and LEED for Homes (LEED-H). The original version, LEED-NC, remains the most widely used system, and has been periodically updated to incorporate new reference standards or minor changes to the credit requirements. The EPA Denver project is pursuing certification under LEED-NC v2.1. Version 2.2 was launched in Fall 2005, and is required for all projects registering with USGBC after January 2006.

The LEED-NC guidelines were originally based on office buildings, but the system has been applied to schools, residential buildings, industrial facilities, and other building types. The LEED rating system is organized into six categories which contain credits and prerequisites. A project must achieve all seven prerequisites in order to attain any level of LEED certification. The 32 LEED credits total a possible 69 points, and different levels of certification are awarded based on the number of points attained:

Certified	26-32 points	Silver	33-38 points
Gold	39-51 points	Platinum	52-69 points

The possible points are not equally distributed amongst the six categories:

Category	Possible Points
Sustainable Sites	15
Water Efficiency	5
Energy & Atmosphere	16
Materials & Resources	11
Indoor Environmental Quality	13
Innovation & Design Process	5

In addition, these points are not equal in monetary cost or environmental impact. For example, a point earned for providing enhanced ventilation effectiveness may require a great deal more effort and cost than a point earned for adding a bike rack or carbon dioxide monitors. Some credits, such as those

[27] For more information on LEED and USGBC, visit http://www.usgbc.org

dealing with site characteristics such as access to public transportation and development density, may not be possible to achieve in some locations. There are also tradeoffs between some of the credit strategies, such as the inherent conflicts between energy efficiency and some strategies for natural or enhanced ventilation.

Successful certification requires attention to LEED requirements throughout design and construction. Decisions about site development and basic building design typically must be made early in design, and detailed calculations, energy modeling, and daylight simulation are typically done during the design development or construction documents phases. Requirements for specific materials and methods are included in construction drawings and specifications, and documentation of these items is collected during design and construction. Activities such as construction waste recycling and building commissioning occur during construction. LEED projects apply for certification at the end of the project, after construction and commissioning is complete, and documentation can be provided for all prerequisites and credits. Certification is based on a review of documents rather than on an inspection by USGBC.

APPENDIX B PROJECT LEED SCORECARD – ANNOTATED

Y	M	N	Sustainable Sites	
Y			Prerequisite 1	Erosion and Sedimentation Control
	X		Credit 1	Site Selection
X			Credit 2	Development Density
X			Credit 3	Brownfield Redevelopment
X			Credit 4.1	Alternative Transportation, Locate Near Public Transportation
X			Credit 4.2	Alternative Transportation, Bicycle Storage & Changing Rooms
X			Credit 4.3	Alternative Transportation, Alternative Fuel Refueling Stations
X			Credit 4.4	Alternative Transportation, Minimum or No New Parking
		X	Credit 5.1	Reduced Site Disturbance, Protect or Restore Open Space
		X	Credit 5.2	Reduced Site Disturbance, Reduce Footprint & Increase Open Space
		X	Credit 6.1	Stormwater Management, No Net Increase or 25% Decrease
	X		Credit 6.2	Stormwater Management, Treatment Systems
X			Credit 7.1	Landscape & Exterior Design to Reduce Heat Islands, Site Surfaces
X			Credit 7.2	Landscape & Exterior Design to Reduce Heat Islands, Roof Surfaces
		X	Credit 8	Light Pollution Reduction
8	**2**	**4**	**14 Possible**	

Y	M	N	Water Efficiency	
X			Credit 1.1	Water Efficient Landscaping, Reduce by 50%
		X	Credit 1.2	Water Efficient Landscaping, Reduce Additional 50% or No Irrigation
		X	Credit 2	Innovative Wastewater Technologies
X			Credit 3.1	Water Use Reduction, 20% Reduction
X			Credit 3.2	Water Use Reduction, Additional 10% Reduction
3	**0**	**2**	**5 Possible**	

Y	M	N	Energy and Atmosphere	
Y			Prerequisite 1	Fundamental Building Systems Commissioning
Y			Prerequisite 2	Minimum Energy Performance
Y			Prerequisite 3	CFC Reduction in HVAC&R Equipment
X			Credit 1.1	Optimize Energy Performance, 15% new, 5% existing
X			Credit 1.2	Optimize Energy Performance, 20% new, 10% existing
X			Credit 1.3	Optimize Energy Performance, 25% New 15% Existing
X			Credit 1.4	Optimize Energy Performance, 30% New 20% Existing
X			Credit 1.5	Optimize Energy Performance, 35% New 25% Existing
		X	Credit 1.6	Optimize Energy Performance, 40% New 30% Existing
		X	Credit 1.7	Optimize Energy Performance, 45% New 35% Existing
		X	Credit 1.8	Optimize Energy Performance, 50% New 40% Existing
		X	Credit 1.9	Optimize Energy Performance, 55% New 45% Existing
		X	Credit 1.10	Optimize Energy Performance, 60% New 50% Existing
		X	Credit 2.1	Renewable Energy, 2.5 - 7.5% Contribution
		X	Credit 2.2	Renewable Energy, 10% Contribution
		X	Credit 2.3	Renewable Energy, 20% Contribution
X			Credit 3	Additional Commissioning
X			Credit 4	Ozone Depletion
X			Credit 5	Measurement & Verification
X			Credit 6	Green Power
9	**0**	**8**	**17 Possible**	

SS credits 2, 3, and 4.1 were achieved based on the selected site, which is located in a dense urban setting adjacent to mass transit and was classified as a brownfield. Credit 1 is uncertain because the finish floor is 6' below the level of the 100-year flood plain, but the team plans to argue this credit. The team designed the site to meet credits 4.2, 4.3, and 4.4 by providing bike racks, showers, and fueling stations and limiting the amount of parking provided onsite. Credits 5.1 and 5.2 are unachievable because the site was completely built out, leaving no area undisturbed. The team is proposing the roof garden as a stormwater treatment system for credit 6.2. Both the site hardscape and the building roof were designed to reflect light and heat to achieve credits 7.1 and 7.2. While the building lighting complies with the requirements of credit 8, the city-mandated street lighting does not.

The roof garden is designed to not require irrigation but the street trees require it, allowing the team to achieve WE 1.1 but not 1.2. Although waterless urinals are being used, the reduction in potable water use for sewage conveyance was not enough to achieve credit 2. The combination of waterless urinals and low-flow fixtures was calculated to save 40% of water, achieving credits 3.1 and 3.2 as well as an innovation credit.

TestMarc was hired to perform commissioning for EA prerequisite 1 and credit 3. Prerequisite 2 requires compliance with ASHRAE 90.1, which is typically a code requirement. Prerequisite 3 requires that no CFC's be used, but CFC-using equipment is no longer sold in the US. The efficient mechanical systems, use of free cooling, daylighting, shading, and underfloor air system contribute to the estimated 35% energy savings. Credit 2 is not achievable since wind power was not pursued and the solar panels may not be installed. Credit 4 is achieved by not using HCFCs or halons in equipment. EPA agreed to purchase 100% of their power from renewable sources to achieve credit 6 and an innovation credit.

Recycling areas are provided on each level of the building to comply with MR prerequisite 1. Credit 1 is unachievable since the project does not involve the

Y	M	N	Materials and Resources	
Y			Prerequisite 1	Storage & Collection of Recyclables
		X	Credit 1.1	Building Reuse, Maintain 75% of Existing Shell
		X	Credit 1.2	Building Reuse, Maintain Additional 25% of Shell
		X	Credit 1.3	Building Reuse, Maintain 100% Shell & 50% Non-Shell
X			Credit 2.1	Construction Waste Management, Salvage or Recycle 50%
X			Credit 2.2	Construction Waste Management, Salvage Additional 25%
		X	Credit 3.1	Resource Reuse, Specify 5% Reuse
		X	Credit 3.2	Resource Reuse, Specify 10% Reuse
X			Credit 4.1	Recycled Content, Specify 5% Recycled Content (PC + 1/2 PI)
X			Credit 4.2	Recycled Content, Specify 10% Recycled Content (PC + 1/2 PI)
X			Credit 5.1	Local/Regional Materials, 20% Manufactured Locally
X			Credit 5.2	Local/Regional Materials, of 20% Above 50% Harvested Locally
		X	Credit 6	Rapidly Renewable Materials
	X		Credit 7	Certified Wood
6	**1**	**6**	**13 Possible**	

Y	M	N	Indoor Environmental Quality	
Y			Prerequisite 1	Minimum IAQ Performance
Y			Prerequisite 2	Environmental Tobacco Smoke (ETS) Control
X			Credit 1	Carbon Dioxide (CO_2) Monitoring
X			Credit 2	Increase Ventilation Effectiveness
X			Credit 3.1	Construction IAQ Management Plan, During Construction
X			Credit 3.2	Construction IAQ Management Plan, Prior to Occupancy
X			Credit 4.1	Low-Emitting Materials, Adhesives
X			Credit 4.2	Low-Emitting Materials, Paints
X			Credit 4.3	Low-Emitting Materials, Carpet
X			Credit 4.4	Low-Emitting Materials, Composite Wood
X			Credit 5	Indoor Chemical and Pollutant Source Control
		X	Credit 6.1	Controllability of Systems, Operable Window
	X		Credit 6.2	Controllability of Systems, Individual Controls
X			Credit 7.1	Thermal Comfort, Comply with ASHRAE 55-2004
X			Credit 7.2	Thermal Comfort, Permanent Monitoring System
X			Credit 8.1	Daylight and Views, Diffuse Sunlight to 75% of Space
X			Credit 8.2	Daylight and Views, Direct Line of Site to 90% of Space
13	**1**	**1**	**15 Possible**	

reuse of an existing building. Opus is on track to recycle over 75% of the construction waste to achieve credits 2.1 and 2.2. The design does not include a significant amount of reused components to achieve credit 3, but large amounts of recycled and regional material (from within 500 miles) were included to achieve credits 4 and 5. Some renewable materials (harvested within a ten-year cycle) will be incorporated into the interior, but not enough to achieve the cost threshold for credit 6. Certified wood products were specified for Credit 7, but the team is awaiting final documentation that the credit threshold was reached.

To achieve the IAQ prerequisites, the project met ASHRAE 62 and banned smoking within the building. The underfloor air system provides increased ventilation for credit 2 and individual control to achieve part of credit 6.2 requirements. Credit 3 was achieved through construction practices and a pre-occupancy building flushout. Low-VOC materials were specified for credit 4. Walk-off mats and exhaust requirements for janitor's closets and copy areas were provided for credit 5. Operable windows were not proposed due to concerns about air pollution, so credit 6.1 was unachievable. The mechanical system was designed to comply with credit 7, and the building facades provided sufficient daylight and view for credit 8.

Y	M	N	Innovation & Design Process		Notes/Alternate ID Credits:
X			Credit 1.1	Innovation in Design, As approved by USGBC - SSc7.1 Covered parking exceedance	ID-MRc4 and/or 5 exceedance or other placemarker
X			Credit 1.2	Innovation in Design, As approved by USGBC - Eco-Pass bus passes for all employees	EAc6 Green power exceedance for 100% green power
X			Credit 1.3	Innovation in Design, As approved by USGBC - Green Housekeeping	ID-Educational Outreach
X			Credit 1.4	Innovation in Design, As approved by USGBC - WEc3 exceedance over 40%	ID-Energy Star equipment purchase program ID-Green guard furniture ID-Jurisdictional Adjustment
X			Credit 2	LEED™ Accredited Professional	
5	**0**	**0**	**5 Possible**		

	0 - 25	Insufficient
	26 - 32	Certified
	33 - 38	Silver
	39 - 51	Gold
	52 - 69	Platinum

Project Points	Maybe
44	4
Gold	

Project Notes:

This facility is required to achieve LEED Silver status at a minimum of 33 LEED points. The goal, however, is to attain LEED Gold Certification at a minimum of 39 points. Total points submitted and credits pursued for official certification may vary depending on the final design and construction process. The final point total and certification rating will not be known until the completion of the construction and commissioning processes.

APPENDIX C GSA'S SUSTAINABILITY PROGRAM

Current Requirements

GSA has required LEED certification for capital projects since fiscal year 2003. While the policy language was evolving there was some confusion about whether projects were expected to actually achieve LEED certification or just use the LEED rating system as a guideline. GSA has since clarified that the requirement is for actual certification, with Silver certification encouraged. Don Horn, GSA's Director of Sustainable Design, says, "GSA deliberately tried to set an achievable goal instead of a stretch goal. If it becomes easy to meet the certified level, we will raise the bar. We also want to wait to see the changes proposed in LEED version 3.0, since it is an evolving system."

While the GSA capital program planning call refers to both government-owned facilities and large capital leases, the facility standards refer only to government-owned facilities. However, GSA has pursued LEED certification on lease projects at the initiative of the region or the client agency, and many regions are starting to apply the requirement to lease build-to-suit projects as well. GSA does not require that projects pursue LEED-CI or LEED-EB certification, but a few projects are currently registered and working towards certification under these rating systems. An effort is underway to build more sustainability requirements into the standard SFO language, but these terms are not LEED-specific.

GSA conducted studies on the cost impact of sustainability and LEED to determine how funding should be allocated. The first study grew out of studies conducted for the design of the Alfred A. Arraj US Courthouse in Denver. The 1997 Green Courthouse Report identified strategies that would have the greatest performance benefit for the least cost, and were generalized for a courthouse in that climate rather than based on a specific design. The cost impact for the ideas was estimated as 2.5% to 7% of the construction cost. Based on this data, GSA increased costs in the 1998 construction cost guide by 2.5% to account for the market premium on sustainable items. Since this premium was thought to be a short-term condition, no money has been specifically allocated for sustainable/LEED costs since 1998. According to Don Horn, "Everyone handled this differently – some set aside this amount and tracked it in their mind. Officially there is no cost tracking for sustainable features, since the costs are now just rolled into the project budget." Costs were projected for specific components such as underfloor air systems, commissioning services, recycled content materials, energy modeling, and LEED documentation so that these features could be required by the P100 and factored into the construction cost guidelines.

In 2004, the Office of the Chief Architect (OCA) commissioned a study on the incremental cost increases due to achieving LEED certification on hypothetical buildings in the Washington, DC climate. The study focused on courthouses and federal buildings, since these were the most common building types that GSA would be building in the 5-10 years following the study. The analysis was performed by comparing the construction cost tables and P100 requirements to changes that would be required to achieve LEED

credits. The courthouse analysis was based on finding the low and high cost for three levels of LEED certification – certified, silver, and gold - and the resulting costs ranged from saving money to an 8% premium. The federal building analysis predicted costs based on different scenarios for the scope of work, such as a full façade replacement and partial façade replacement. To predict soft costs, the study team interviewed eight to ten firms that had worked on sustainable GSA projects to gather anecdotal information on the extra time that might be required. This study addressed only first costs, without examining the potential benefits or cost-benefit relationships. GSA has not commissioned any new studies on this issue since 2004.

GSA has been experimenting with penalties for not achieving LEED certification on lease projects, but has not found any useful way to control this for federal construction projects. Most of the projects that began after GSA's mandate to be LEED certified are still in construction or were delayed, so it is too early to know what percentage of the projects will actually achieve certification. According to Don Horn, "We don't have a list of the status of projects and what happened with LEED. I think most are registered and working toward LEED, but it is too early to tell the results." Fifteen GSA projects have been LEED certified to date, including five government-owned buildings and six lease projects. The five federal construction projects achieved the basic level of LEED certification, while the lease projects include four Silver and six Gold certified projects. Don Horn believes the success of these lease projects is based on two things: "The lease projects move much quicker, and have more budget flexibility. Developers have the ability to control the budget by shifting between first costs and operating costs to get a return on the investment." GSA's Heartland Region in Kansas City has been very aggressive in requiring LEED certification on lease projects, and will soon have one-third of their lease inventory certified.

Recent Changes

GSA has not recently set any requirements, such as targets for energy or water savings, beyond LEED certification. The standards say that OCA and the Energy Center of Expertise (ECE) will set an energy target for the project, and if this doesn't happen then the team should aim for some improvement over ASHRAE 90.1. In 2006, nineteen federal agencies signed a memorandum of understanding (MOU) called Federal Leadership in High Performance and Sustainable Buildings. Intended as a set of guiding principles, it consists of a list of fifteen items that should be part of every project. These include reducing energy use by 30%, recycling at least 50% of construction waste, reducing potable water use by 20%, using low-emitting materials, performing commissioning and measurement and verification, and entering building data into DOE's High Performance Building database. ECE collects energy consumption data for all GSA-owned buildings, which can be used by facility managers and regional energy coordinators.

While these standards are clearly related to LEED credits, the MOU does not mention LEED. GSA and the other agencies agreed to incorporate these requirements within 180 days of signing. GSA is working

on how to implement these changes now, since the P100 is rewritten every two to three years, and the current version was released in 2005. These new standards will be used as a starter scorecard for LEED, to shape the choices made on all federal projects. Since the new standards require 30% energy savings, Don Horn says, “I would like to see a requirement that project modeling shows a 30% improvement in performance before the commissioner will sign off on a project. But I’m not sure when, or if, this will happen.”

Training and Outreach

GSA’s Sustainable Design program, created in 1999, consists of Dorn Horn and 2 staff members who are both architects with green design experience in the private sector. The program is part of the Research and Expert Services Division of the Office of Applied Science. The staff provides sustainability training in each region. Their goal is to meet with as many people as possible, ideally fifty from each region, but typically the training sessions have been attracting twenty to forty people. The training is aimed at reaching all of the staff roles, and is organized into modules so they can tailor the training to the region’s questions. Modules include Environmental Design 101, Integrated Design Charette, P100 and Facility Standards, Introduction to LEED, Implementing LEED, LEED-EB, LEED-CI, Leasing and SFO language, water, energy efficiency, green roofs, and commissioning. While GSA supports LEED accreditation if a staff member expresses interest, Don Horn prefers that people attend the in-house training first since it is tailored to GSA and is more comprehensive.

Beyond training, the program provides resources and guidance for project teams and answers technical questions on strategies and LEED issues. The Sustainable Design staff responds to incoming requests for support, as well as seeking out projects for assistance. They interface with the regions through monthly conference calls with the Build Green network, consisting of at least one person from each region. A Build Green Coordinator in each region is also used as the point of contact for training, information requests, and dissemination of information on conferences and other opportunities.

Future

A few developers, including Opus and CB Richard Ellis, have already successfully delivered multiple LEED certified projects for GSA. Based on these early successes and the advantages discussed above, certification of lease projects is expected to increase. Don Horn predicts that sustainability will continue to be integrated into GSA’s work, and that GSA will remain at the leading edge, taking risks that the private sector may not be able to. Don Horn says, “I’d like to see GSA stay at that edge by pursuing zero energy buildings, focusing on reducing impact on the environment, and promoting restorative effects on the communities we’re in. We need to get beyond the current focus on meeting LEED points, and also focus on performance measurement and follow-up.”

APPENDIX D FLOOR PLANS

Ground Floor

Typical Office Floor

Ninth Floor & Green Roof

APPENDIX E PROJECT SCHEDULE

March 2004	SFO
July 2004	Offers due
August 2004	Development contract to Opus team, project kickoff
June 2005	Groundbreaking
October 2005	CDs complete
Aug 2005	Start of construction
July 2006	Original anticipated occupancy (per SFO)
Nov 2006	Construction completion
Nov 2006	Anticipated occupancy

APPENDIX F PROJECT TEAM

The relations of the various organizations and individuals that worked on the project.