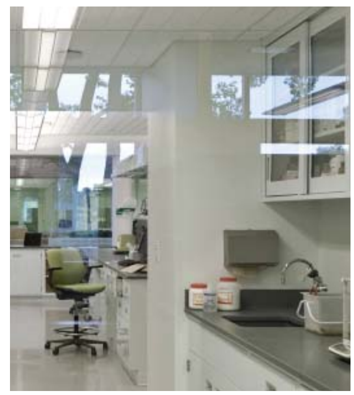
Plant Conservation Science Center

Chicago Botanic Garden



BOOTH HANSEN

Contents

1. Executive Summary

By 2050, the world could lose tens of thousands of plant species—with some estimates predicting a loss of up to one-third of the world's plant species (about 150,000).

In the United States alone, we risk losing 25 percent of the plant species that exist today. Of the millions of acres of native Midwest prairie that existed years ago, only a tiny fraction remains today. These fragments are in danger of disappearing completely, and with them, the birds, insects, and other animals that depend on them. Including us.

The disappearance of one single species is a lost opportunity: a chemical or genetic answer that could solve a medical problem or change the way we live.

The Plant Conservation Science Center's mission of conserving plants is one of the most significant challenges of our time. From studying soil to banking seeds, from restoring habitats and protecting endangered plant species to developing new ones, Garden scientists are fighting plant extinction, pollution, and climate change through diverse and exciting research.

The goal of the Plant Conservation Science Center is make accessible to a wide variety of building users, science and how it affects each of us. The laboratory design has three important aspects that differiate it from others and are directly derived from this mission.

Education

There are three aspects to education in the building. First, the Plant Conservation works in partnership with Northwestern University's plant biology and conservation program. Secondly, the public is allowed to "engage" in the science research through direct observation and exhibits. Third, using the building as a teaching tool for the visitor. An example of this is the green roof research area which utilizes the envelope of the building as a "living" laboratory.

Transparency

For the scientists doing research in the building, a sense of community and collaboration is fostered by allowing laboratories to viewed from each other and the offices.

Sustainability

With the design of an energy efficient envelope and innovative building systems, this project provides the minimal impact to the environment.

View of the Plant Conservation Science Center from within the Botanic Garden

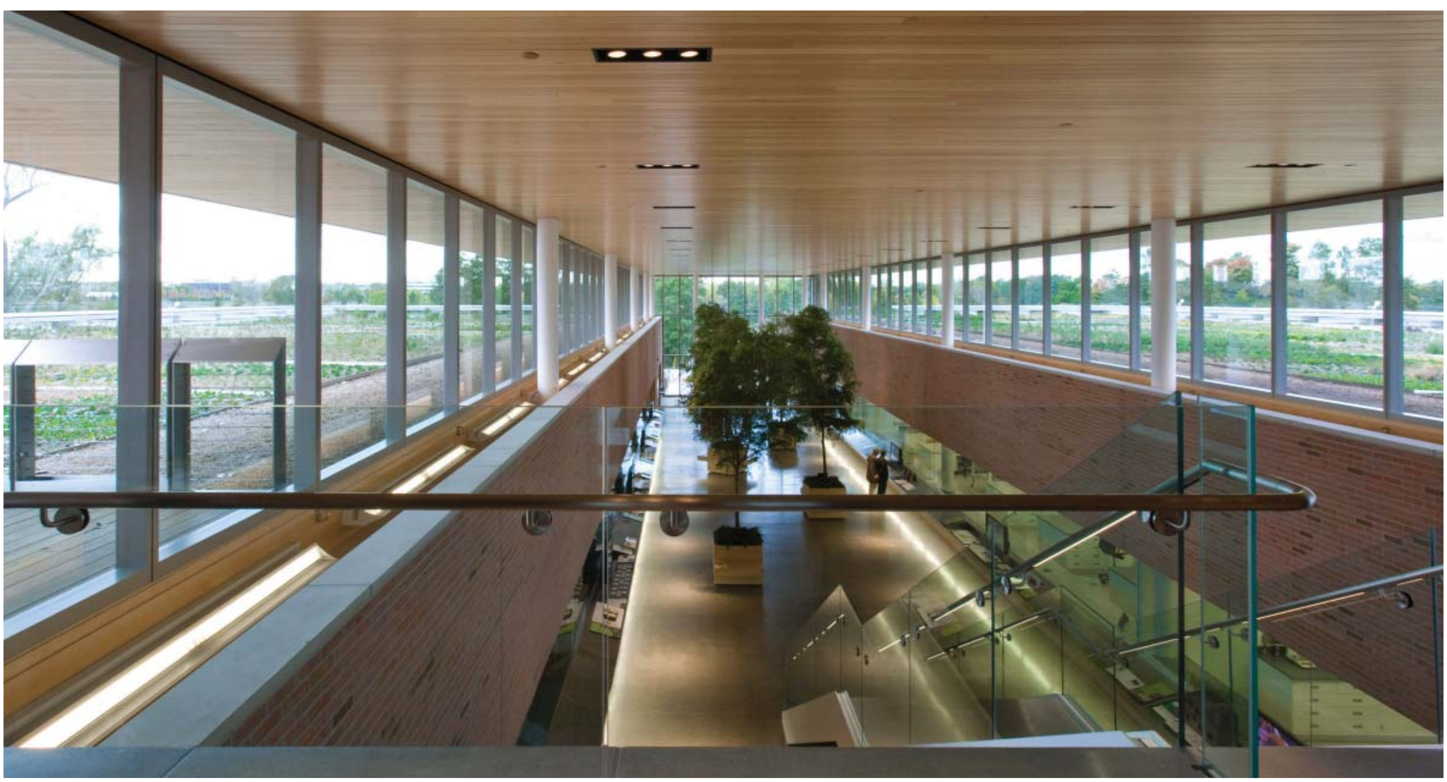
2. Client Mission

The mission of the Chicago Botanic Garden is to promote the enjoyment, understanding, and conservation of plants and the natural world.

The Garden continues to strive to meet the lofty goals set more than a century ago. Located in Glencoe, IL, the 385-acre Garden features 24 display gardens and three native habitats, uniquely situated on nine islands surrounded by lakes. With its world-renowned plant collections and displays, is one of the country's most visited public gardens and a preeminent center for learning and scientific research.

The Chicago Horticultural Society was founded in 1890. At its heart was the understanding that the city of Chicago was incorporated with the Latin words *Urbs in Horto*, meaning "city in a garden." In 1963, the Chicago Horticultural Society was granted 300 acres of forest on the outskirts of the city, and the Chicago Botanic Garden established roots. With the ground-breaking for the Garden in 1965 and its opening in 1972, the Society created a permanent site on which to carry out its mission. The mission encompasses three important components: collections, education, and research.

Site Plan with Booth Hansen projects noted



From the Mezzanine, both the laboratories and the green roof are visible

3. Goals

From its founding, the Garden has hired leading architects, beginning with the master plan by John Simonds and Geoffrey Rausch. Edward Larabee Barnes designed the Education Center as the Garden's first building in 1977. The Chicago Botanic Garden continues to develop gardens and educational facilities with a meticulous eye toward its original mission.

With its world-renowned plant collections and displays, the Chicago Botanic Garden is one of the country's most visited public gardens and a preeminent center for learning and scientific research. Funding of facilities for science research has come from many individual patrons and foundations that support the broad mission of the Garden. Sponsorship of many of the individual laboratories within the Plant Science Conservation Center is attributed to those generous donations.

Plant Science Conservation Goals:

- Conserve plants as one of the most significant challenges of our time
- Save over 30 millions seeds from 1500 species of the tall grass prairie
- Create a Herbarium to expand study of hundreds of thousands of rare and endangered specimens
- Partner with Northwestern University in the only PhD program in plant biology and conservation in the U.S.
- Study and assess plant medicinal and industrial uses
- Research soil and carbon absorption
- Research green roofs for sustainable, environmental, and ornamental purposes
- Engage and educate the public on this research 364 days per year

Project Design Goals:

- Bring "BIG SCIENCE" to public
- Create a Learning Experience for the Public in central public atrium
- Make Science visible with "Window" to activities
- Create a sustainable (Minimum Carbon) Design (LEED Gold or higher)
- Provide Interactive Places for Creative Thinking
- Enhance and Integrate Architectural Design of South Science Campus
- Fit into Garden context where natural setting is primary; design views from rest of Garden
- Design a building that is efficient and simple

View of Plant Evaluation Garden in front of Plant Conservation Science Center with visitors arriving by tram

Design Overview

Booth Hansen designed a world-class laboratory to serve plant conservation science research as well as educate the public about this research within a new one-story 37,700 gross s.f. masonry and glass building. Ten laboratories and offices for forty researchers (called principal investigators) are the primary programmatic elements along with an expanded herbarium, an enlarged seed vault facility, seminar and conference rooms, and a plant science library. All of the educational spaces have a direct connection to nature, emphasizing the basis of the research conducted in the facility.

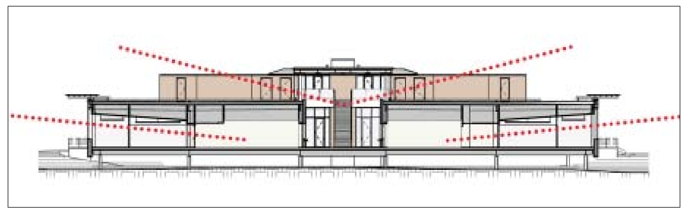
Visitors in atrium examining science displays and viewing laboratories

Main entrance accessed by a bridge over a raingarden

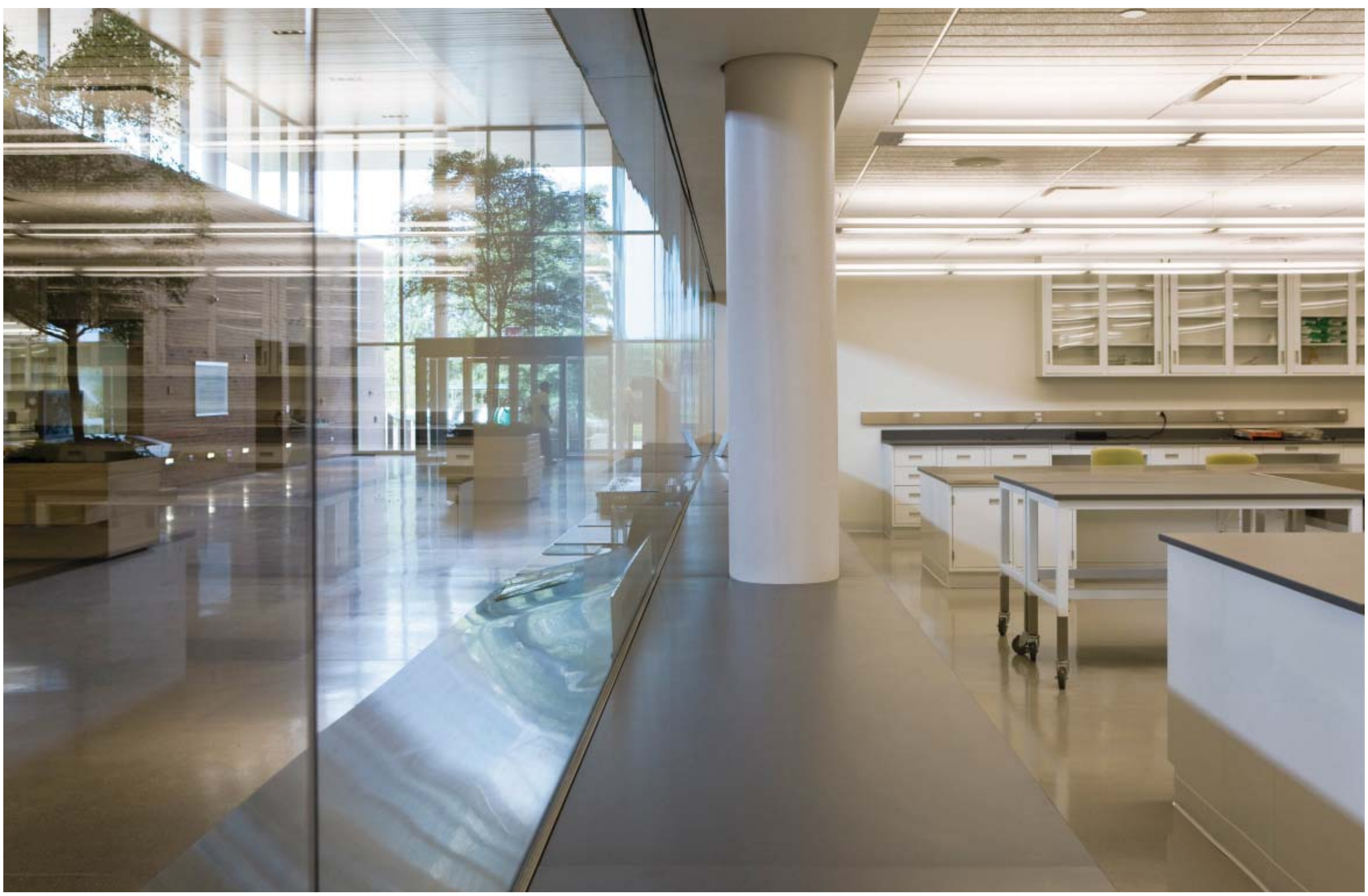
Transparency

One of the most critical design objectives of the Chicago Botanic Garden was to make the science of plant research accessible to the public. Thus, the building is designed from the "inside-out" around a central public viewing gallery. The inward-focused laboratories provide scientists with the unique opportunity to engage the public, including other scientists, with virtually every open lab being visible to every other open lab. The 2-story central gallery runs the length of the building, with clerestory windows filling the space with natural light. Continuous windows line both sides of the gallery, allowing the public to view researchers working in the laboratories. In addition to observing conservation science research being conducted in the labs, hands-on exhibits engage visitors and provide information about the Garden's research programs and the importance of plants in everyday life.

The transparency of the central gallery allows the researchers to receive indirect natural light and provides a sense of connection to the other laboratories. A sloped ceiling design with clerestory windows allows daylight to extend deep into the interiors and the open office areas. Scientists' offices are located at the building perimeter, encouraging that initial "spark" of creativity and discovery that may come from nature itself. The unique setting of the building within the Chicago Botanic Garden grounds offers unparalleled views and creates an ideal environment for contemplative thought.



Section diagram shows how natural light filters into the building



Transparency between laboratory and atrium that allows scientific research to be available to visitors

Site and Building Plan

Due to its site on an existing floodplain and the Garden's desire to have minimal site impact, the entire building is raised above of the flood level to prevent flooding from affecting the building, to maintain an undisturbed grade, and to allow for a rain garden for site runoff. The building plan was conceived as two simple identical "bars" of offices and laboratories separated by the central atrium for the public (nearly 800,000 visitors a year) to view the research functions of the Garden. The "bars" are clearly articulated with private offices that house the principal investigators on the exterior wall and laboratories fronting the public atrium. Areas of collaboration are located throughout for new building in the open office area, conference and seminar rooms, and library. The roof of the building has a green roof over 50% of its area to allow for green roof research and a display garden.

Building Materials

The materials used in the Plant Science Center fit into the overall established palette of the Garden. Natural brick, glass, wood, and steel allow the building to coexist in harmony with its surroundings. Materials utilized inside the building such as recycled rubber flooring, exposed concrete floors, and countertops made from recycled slate were utilized for optimum durability and functionality and to provide an easily maintainable, minimal off-gassing environment. Roof overhangs known as brise-soleil, are constructed of photovoltaic cell panels along with the green roof make sustainable design more visible to the visitor. The buildings are smoke-free facilities that are universally accessible to the public and staff.

Diagrams indicating integration of building components

Ground Floor Plan with colored zones indicating program elements

Laboratory Planning Principles

The laboratories were designed with the following planning principles:

• Interaction, Flexibility, Safety
• Establish the "Lab Module" to allow for flexibility
• Provide access to natural light
• Foster key adjacencies: office to lab, lab with views, lab to public, progression of low to high hazard

Program

The laboratories are a diverse collection ranging from dry labs (no hoods) to hood-intensive chemistry and biology laboratories. The building is organized into two laboratory blocks based on the programmatic requirements of the research. The west lab block primarily houses "dry labs" with fume hoods limited to specific support rooms. The east block houses biology/chemistry laboratories. Each laboratory block is served by dedicated mechanical rooms, AHUs, and utilities. Each block is considered self-sufficient with minimal cross-over of utilities or programs

Laboratory Classification

To provide appropriate ventilation to the laboratories and maximize energy efficiency of the building, careful analysis of the process, chemical use, and fume hood requirements was conducted to consolidate wet labs (with hoods) from dry labs (without hoods). Consolidating similar laboratories and/or accommodating special requirements within a dedicated support lab allowed for significant reductions in ventilation requirements and overall energy use.

Flexibility

The standard planning principles of multiple labs allow scientific programs to expand into adjacent spaces without the need for any modifications to the laboratory or infrastructure (passive flexibility). Distribution of utilities allows for modifications to be made to accommodate any future scientific processes (active flexibility)

View through fume hood zone to laboratory beyond

Lab module allows for flexibility
Neutral colors allow research to be more visible

4b. Laboratory Design

Laboratory Module

The basic planning module for the Plant Conservation Science Center is 32' x 32' with 10'- 8" centerline between benches. The modules are designed so that "plug-n-play" flexibility can be accommodated anywhere within the lab block. Walls can be located anywhere on the 10'-8" module to combine labs or enclose, as necessary. As a planning principle, labs were designed as "open" by rule, and "enclosed" only where required by function or safety. A 4' wide planning module for the bench allowed for maximum flexibility during the planning process and for modifications after construction. The planning principle of organizing the lab from low to high hazard is the basis of the laboratory planning, hood location, and integration of mechanical systems. Additionally, this planning principle locates the inherently more interesting scientific instruments closer to the viewing windows for the public.

Safety

The entry to every laboratory is provided with handwashing sink, lab coat/safety glasses storage, safety shower/ eyewash, and emergency station with first-aid and fire extinguishers. The standardization of this design feature in all the labs encourages safety protocols for lab coats and handwashing. The visually prominent safety station reduces the time required to locate these facilities in the event of an injury or chemical spill.

View of laboratory with safety entry zone identified by colored wall

Air Systems

Two variable air volume air handling units serve the building with (in order of airflow) a minimum outside air (OA) section containing a minimum OA damper, minimum OA airflow measuring station (AFMS), pre-filter filters and a heat pipe heat recovery coil in parallel with an economizer section; pre-filters and secondary filters; hot water preheat coils; chilled water cooling coils and a plenum type supply fan. The amount of outside air brought into the building is approximately 50% of the total maximum supply airflow due to the fact that the laboratories using chemicals are fully exhausted to the outside.

Air is delivered to the offices with standard VAV terminal devices containing reheat coils and to the labs via venturi type variable air volume air valves with reheat coils located downstream from the air valves. Air from the labs using chemicals is exhausted through the fume hoods and room general exhaust with venturi type air valves. Lab exhaust is via two variable volume high plume exhaust fans with OA intakes. The exhaust fan airflow is reduced in response to the varying lab airflow until a set minimum is reached; this set minimum is the airflow required to maintain an adequate exhaust plume height. If the lab exhaust is reduced further, the OA dampers are modulated. Air from the offices and other non-lab areas is returned to the AHUs via two mixed flow fans with variable frequency drives (VFDs).

Heating Systems

The heating system consists of two 1,720,000 Btu/hr high efficiency condensing hot water boilers that serve the air handling unit preheat coils, the space reheat coils and the in-floor radiant heating.

Cooling Systems

The building is cooled by a high efficiency 150 ton centrifugal chiller utilizing pond water for condenser water. A primary variable flow chilled water system distributes chilled water to the AHU cooling coils and the in-floor radiant cooling.

Equipment above ceiling

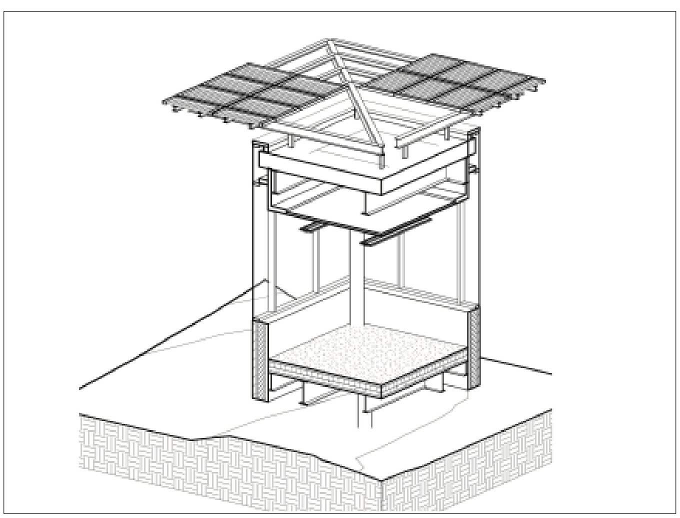
Lab exhaust fan

4c. Mechanical Systems Engineering Design

All life depends on plants. Plants provide us with everything we need to live our lives — the air we breathe, the water we drink, food, clothing, medicine and shelter. Careful attention was paid in this project to protecting these precious resources by providing an environmentally-efficient facility. The following features will help the building to earn a LEED Gold Certification from the U.S. Green Building Council.

Clean Air

Building materials were selected to have no or low volatile organic compounds, such as paints and coatings, adhesives and sealants, carpet systems, and composite wood and agrifiber products. Segregated areas are provided for hazardous chemicals or gases with containment drains and high level of air filtration. Humidification has been provided in the building to maintain proper laboratory conditions and improve human comfort. A number of system features provide control for and verification of acceptable indoor air quality including monitoring and control of the minimum outside airflow with outdoor air airflow measuring stations and dampers. Additionally, an environmental monitoring system that samples air from building spaces, senses temperature, humidity, concentrations of CO_2, VOCs and CO, and interfaces with the Building Management System for indoor air monitoring and demand-controlled ventilation.



Three-dimensional corner detail, showing integrated solar panels

Photovoltaic cells under construction

Encouraging Alternative Transportation

At least seven bicycle racks and two showers are provided for staff to commute via bicycle. Preferred parking for "Hybrid Vehicle Parking Only" and "Carpool/Vanpool Parking Only" are provided.

Envelope Design

Careful attention was paid to design of the building envelope with thermally broken windows, low-E and high-performance glass, continuous insulation of exterior walls and roof, and air lock vestibules at all entrances. The envelope incorporates the following performance criteria:

1. Walls: U-value of 0.050 (R-20) bettering ASHRAE Standard 90's requirement of 0.084 (R-12)

2. Roof: U-value of 0.032 (R-31) bettering ASHRAE Standard 90's requirement of 0.063 (R-16)

3. Windows:
a. The buildings window-to-wall ratio is 46%, exceeding ASHRAE Standard 90's limit of 40%. Other energy saving features offset the energy increase due to the high window-to- wall ratio.
b. U-value of 0.458 and a Solar Heat Gain Coefficient (SHGC) of 0.30; both better ASHRAE Standard 90's requirements of a U-value of 0.057 and a SHGC of 0.39.

4. Exterior shading: Overhangs that extend 8 feet from the face of the building shade the windows. The overhangs are constructed with photovoltaic panels.

Electrical & Lighting Systems

The efficiency in the electrical system design was gained with utilizing high-efficiency lighting with occupancy sensors throughout the building. Most spaces at the exterior walls contain photocells that allow maximization of daylight and reduction of energy use for lighting. Twenty-three electrical panels are being metered to allow for future monitoring and verification of the predicted energy savings.

Air Systems

Energy saving aspects of the air systems include:

1. Low velocity AHUs: Air handling units selected with low velocity coils and filters (between 350 fpm and 400 fpm to full flow) reduces the pressure loss across the filters and coils and results in a lower fan power draw as compared to the typical 500 fpm face velocity.

2. Heat recovery: Pre-heating/pre-cooling of outside air via a heat pipe heat recovery system that recovers heat from the laboratory exhaust systems. The heat recovery coil is located in the outside air intake airstream rather than the mixed airstream in order to maximize the heat transfer between the two airstreams and eliminate the pressure drop of the coil during economizer mode.

3. VAV laboratory systems: Variable air volume laboratory supply and exhaust. Note: ASHRAE Standard 90 requires that a laboratory ventilation system over 15,000 cfm must utilize either VAV controls or heat recovery; the Chicago Botanic Gardens system incorporated both of these energy savings methods, thus surpassing the requirements of ASHRAE Standard 90.

4. Fan-assisted natural ventilation of central atrium viewing gallery: The acceptable space temperature range in the central atrium viewing gallery is expanded; to be initially set at between 60F and 80F. No supply air from the AHUs will be provided from the AHUs when the outside air temperature is between 55F and 85F. An exhaust fan will cycle on if the space temperature rises above a setpoint to be determined (approximately 70F to 75F).

Heating Systems

The combination of the high efficiency condensing boilers and the in-floor radiant heat provides exemplary energy performance. The State of Illinois Energy Code, which is the International Energy Conservation Code, requires hot water boilers greater than 300,000 Btu/hr but less than 2,500,000 Btu/hr to have a rated minimum efficiency of 75%. This project's condensing boilers' efficiency is 87.5% at 120F return water temperature and 93% to 96% efficient at 80F return water temperature. The critical factor that ensures maximum efficiency from a condensing boiler is that the return water temperature be kept below 120F, much lower than conventional systems that operate at return water temperatures in the range of 140F to 160F.

Cantilevered "brise-soleil" solar panels shade the principal investigators' offices

Heating Systems (continued)

In order to realize the efficiency of condensing boilers, the following strategies minimize the return water temperature in the building:

1. In-floor radiant heat: The radiant system is designed with a return water temperature that varies from 80F to 100F depending on the outdoor air temperature; at an outside air temperature of 0F or less, the return water temperature is 100F; at 32F outside air temperature, the return water is 90F and at 65F and greater outside air temperatures, the return water temperature is 80F.

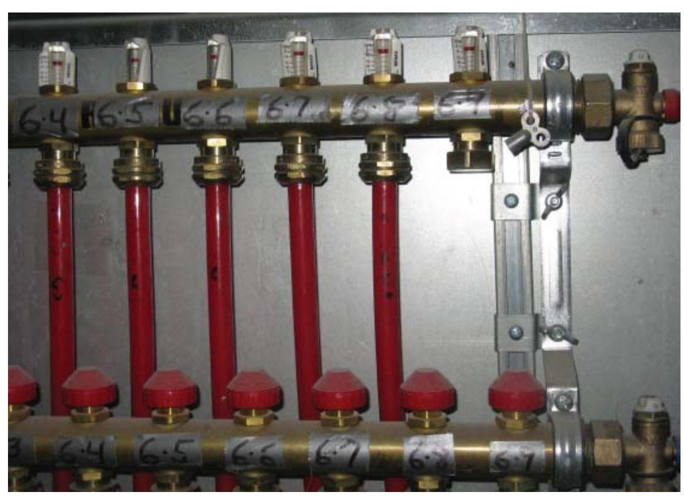
2. Heating equipment at lower water temperatures than is typical: Preheat coils, reheat coils, unit heaters and cabinet unit heaters were all selected with an entering water temperature of 140F and a leaving temperature of 120F; less than the more common 180F to 160F selection temperatures.

3. Resetting of heating hot water temperatures: At an outside air temperature of 0F or less, the hot water supply temperature for the hot water loop serving the preheat coils, reheat coils, unit heaters and cabinet is 140F; at 32F outside air temperature, it is reduced to 120F and at 65F and above the hot water supply temperature is 100F.

These strategies result in the boilers operating at 89% to 93% efficiency as the outdoor air temperature varies from 0F to 65F.

Radiant floor tubing

Radiant floor valves



Radiant floor valves - detail

Cooling Systems

Energy efficiency features associated with the chilled water cooling system include the following:

1. Utilizing pond water for condenser water: The building is cooled by a high efficiency 150 ton centrifugal chiller utilizing pond water for condenser water. The use of pond water for condenser water yields a significant energy savings as compared to condenser water via a cooling tower.

2. A primary variable flow chilled water system: This system maximizes energy savings in a reliable and simplified manner as compared to a primary/secondary system by eliminating both a set of pumps and the possibility of mixing return water into supply water via the primary/secondary bridge.

3. In-floor radiant cooling: This project utilizes radiant floor tubing installed as part of the in-floor radiant heating system to provide cooling. Cool water from the main building chiller is mixed to obtain the desired chilled water temperature and delivered to the floor tubing system during the cooling season. The design assumes that this radiant cooling provides for 1.5 watts per square foot (W/sf) of cooling, as compared to the approximately 5 W/sf of equipment load.

This method of cooling reduces the cooling required from the air system. Because the lab air is "once-through," any reduction in airflow to the labs eliminates the need to cool outside air, thus reducing the load on the chillers. The energy model predicts that radiant cooling saves 145,400 Btu/hr as compared to the building without radiant cooling. Because there is little historical data to determine how much cooling would be achieved by in-floor radiant cooling, the desire is for actual cooling achieved to be greater than the 1.5 W/sf to achieve greater than predicted energy savings.

Energy Reduction

A whole building energy model utilizing the E-Quest software predicts the following annual savings as compared to the ASHRAE Standard 90 Base Case building:

Annual electric savings: 192,850 KWH/year
Annual gas savings: 17,280 therms/year
Annual energy cost savings: 39.6%
(this savings achieves 9 out of 10 LEED EAc1 points)

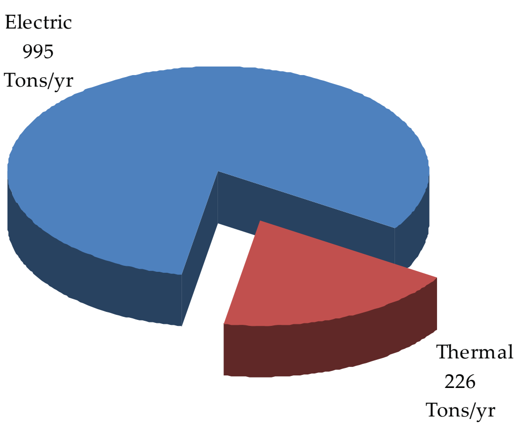
The table below summarizes the reduction in carbon emissions associated with this building as compared to the ASHRAE Standard 90 Base Case.

Carbon Source	Carbon Emissions of ASHRAE Standard 90 Building (Tons)	Carbon Emissions of Plant Sciences Building (Tons)	Carbon Emissions Reduction (Tons)	Equivalent Passenger Cars Removed from Road
Electric	995	764	231	38
Thermal (Heat)	226	122	104	17
Total	1,220	886	334	55

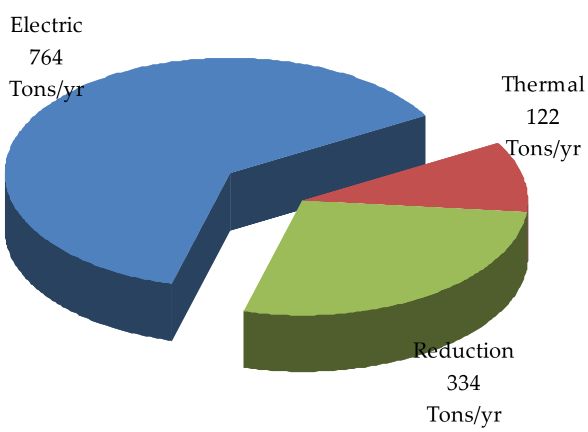
Interior clerestories allow for natural ventilation and natural light

Energy Reduction (continued)

This reduction in carbon emissions is significant as illustrated by the following pie charts. The carbon emissions associated with the energy reduction of the final Plant Conservation Science Center will be 27% less than if the building simply satisfied ASHRAE Standard 90. In addition, the high-efficiency low-NOx boilers will reduce NOx emissions by 298 lb/year, or 81% as compared to a standard EPA boiler.



Carbon emissions of ASHRAE baseline building



Carbon emissions of Plant Conservation Science Center

Green Roof Garden and Solar Power

Light-colored roofing and a green roof garden (16,000 square feet) will cover over 50 percent of the roof area, reducing the heat island effect. The green roof system reduces stormwater run-off and naturally filters any remaining stormwater. The green roof is unique in that it extends a living laboratory onto the envelope of the building. Photovoltaic panels on the roof overhangs will provide 54.7kW system to supply over 6% of the power required by the building. The design of the solar panel installation also provides for shading on the windows, reducing glare and heat gain.

Roof Garden

Limit Land Impact

The compact building design with minimal exterior enclosure limits thermal exposure and minimizes land impact. This is enhanced by restoring and preserving the landscape surrounding the area with native plants. The 16,000-square-foot green roof garden creates additional open space. Due to an existing floodplain and the Botanic Garden's desire to minimize site impact, the entire building is raised on steel and concrete piers so that the building has no impact on natural site runoff.

Pollution and Waste Prevention

Over seventy-five percent of the construction waste was diverted from disposal. An erosion and sedimentation plan includes silt fencing, sediment traps and basins to prevent pollution of the surrounding area by construction run-off.

Recycled, Regional and Eco-Materials

Over forty percent recycled materials (post-consumer and half from pre-consumer) were utilized in the building. Sixty-five percent regionally extracted, processed and manufactured materials (within 500 mile radius) will be used in the building. FSC-certified wood will be used for 50 percent of the value of all wood used on the project.

Water Efficiency

A rainwater glen surrounds the building to collect rainwater draining from nearby parking areas and filters it within the Garden's plant community. The green roof garden system holds rainwater to be used later by the plants. Native plants will be used in landscaping, reducing the need for irrigation by over 50 percent, and no potable water is used for irrigation. The building uses 30 percent less water through use of low-flow plumbing fixtures and valves.

Southwest corner of building indicating building "floating" above floodplain

The Plant Conservation Science Center provides laboratories and teaching facilities for more than 200 Ph.D. scientists, land managers, students, and interns whose research is critical to Garden's efforts to save the planet by saving the plants. A partnership with Northwestern University forms a major component of these efforts, offering a new doctoral program in plant biology and conservation that is headquartered at the Center. The doctorate program provides a foundation in plant ecology, evolution, and biology, and in applied plant conservation theory and methods. The array of laboratories and support facilities listed below serve both the academic program and the science professionals who work for the Botanic Garden.

Plant Systematics Laboratory

Knowing the name of a plant not only allows one to list it, but also to find information on its ecology (habitat, flowering time, pollinators, etc.) Thus, it is fundamentally important when describing a plant community for ecological research or restoration activities or when preserving rare and endangered species to have correct identifications. It is also important to know how they are related to other plants from an evolutionary standpoint; i.e., where they fit into the tree of life. Plant systematics is the study and classification of plants and leads to the understanding of how they are related to one another. All of the research activities in the plant genetics, ecology and population biology laboratories will depend upon the work that is conducted in the Plant Systematics Laboratory, connected as it is to the Herbarium. Plant systematics is used as a basis for fields as diverse as restoration, medicinal research or historic climate changes. In addition to systematic research, activities in this lab includes the preparation, mounting and accessioning of new herbarium specimens. The lab is a place for staff and scientific colleagues to study the herbarium collection.

Herbarium

The herbarium is a reference collection of preserved plants complete with important data such as collecting location and date, ecological conditions and other plants found in close proximity. The herbarium is a historical record, documenting what plants grew where and when. It is used to document when an invasive species arrived in an area, or the last documented record of a rare plant, or movements of plants due to climate change. It is useful for identifying unknown plants and describing a new plant species collected in the field, comparing unidentified plants against known species, or determining the variability between closely and distantly related plants. A herbarium collection is also a source of DNA, which can be extracted from leaves or other plant material. It also allows researchers to document the specific plants that have been studied as part of a research project by creating a "voucher" specimen that can be used by future scientists to verify the identification of the plants that they studied. Additionally, a herbarium is invaluable for educational purposes such as training staff and volunteers in the identification of native plants, and for courses in plant taxonomy and morphology. It is also a shared resource that supports research projects at institutions from around the world. The Garden's Herbarium will be capable of housing hundreds of thousands of specimens.

Microscope station in laboratory

Josephine P. & John J. Louis Foundation Microscropy Laboratory

The Microscopy Laboratory focuses on two critical functions. First, the laboratory houses several microscopes outfitted with digital image capture and analysis systems that are used for the examination of plant anatomy, plant fossils, fungal specimens and other types of samples. A fluorescent microscope in a dedicated dark room within this lab allows scientists to measure the ability of pollen grains to sire seeds. This close examination of fertilization is used in plant breeding and the study of plant reproduction in natural populations.

The second function of the lab is found in the geographic information system (GIS), which was made possible by a grant from the National Science Foundation. For example, plant locations are viewed spatially, and overlay maps of soil conditions and other environmental characteristics can predict other locations where a species might occur or determine appropriate sites for restoration.

Population Biology Laboratory

Rare and endangered plant species survive in part because their population size is large and genetically diverse enough to support continued reproduction and healthy populations (e.g., attract pollinators and not suffer from problems due to inbreeding). Many factors can affect their reproduction including habitat fragmentation, climate change, plant diversity, changes in pollinators and wild fires. Scientists, interns and graduate students in the Population Biology Laboratory conduct research on how these and other factors impact the genetic diversity and thus, long-term survivability of affected plant populations. The lab contains two environmental chambers with temperature and humidity controls, as well as a dissecting scope with a camera and computer.

The Abbott Ecology Laboratory

The Chicago Botanic Garden is actively maintaining, restoring and/or recreating five local native habitats. These activities inform restoration ecologists a great deal about habitat management that can be applied in other regions. The Ecology Laboratory enables scientists to study community ecology, water quality and other ecological factors important to our ability to effectively restore and manage these environments. What is learned is shared with other organizations involved in similar pursuits. The equipment in this lab includes several types of microscopes, such as dissecting microscopes and stereomicroscopes, and an automated analyzer for water and soil nutrient analyses.

View of the building amidst the diverse plant population of the Chicago Botanic Garden

Growth Chambers

Two Growth Chambers serve the Population Biology and Ecology Laboratory. Each has controlled temperature, light and humidity to grow plants for experiments that require very specific environmental conditions and careful monitoring. Approximately 10 feet by 10 feet, the chambers are equipped with bottom-lit shelving for plants on lower levels, and a watering system. The rooms are used by conservation scientists from different disciplines to grow plants being studied from seed. Plants may be in the growth chamber for their entire life cycle, which may last from a few months to a couple of years, or they may be evaluated for six months before they are set out in the field for further study. The ability to grow these plants in a controlled setting allows the scientists to study differences in plant characteristics that might predict, for example, how the plant may fare in different environmental settings with site-specific pollinators.

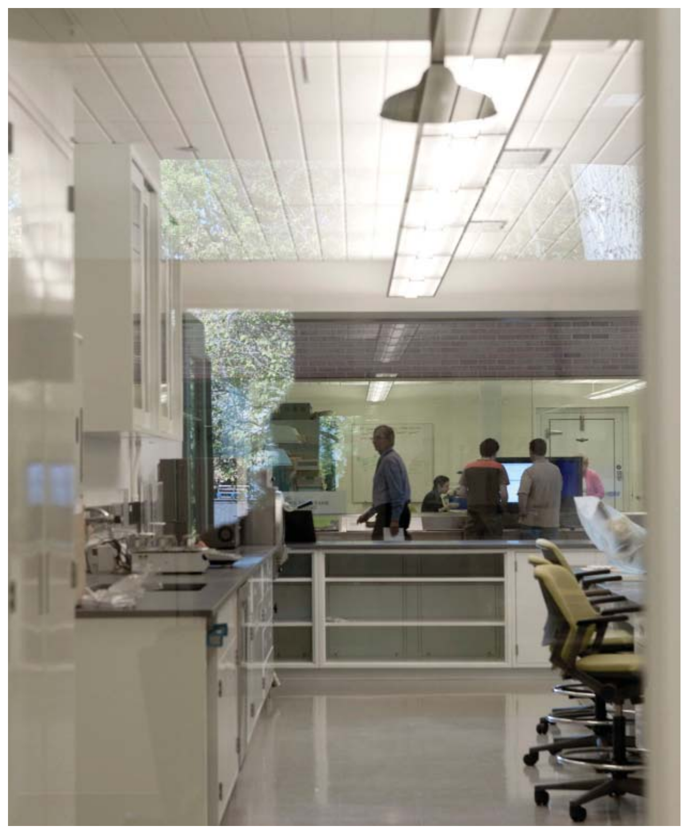
Soil Laboratory and Soil Preparation Laboratory

Soil contains intricate ecological networks linking plants, soil and soil microbes. Research has documented that plants grow and survive better in soils that contain the appropriate fungi and other microbes. These laboratories houses research on the connection between soil, microorganisms and plants, how human activities are impacting these networks, and how these networks are involved with issues like carbon sequestration. Because the soil being studied contains unknown microbes, fungi and other possible contaminants, the lab is a closed environment. The Soil Preparation Lab is the area of entry where the soil can be processed before it comes into the Soil Lab. Combined, these two labs cover 1,200 square feet in the Plant Science Center. The Soil Lab contains a fume hood, which is designed to capture contaminants that are then captured and filtered out so as not to get into the ventilation systems of other laboratories.

Interpretive displays help explain the scientists' work to visitors

Dr. Scholl Foundation Seed Quarantine Chamber

After seeds are collected, they are placed in the Seed Quarantine Chamber to ensure that no pests or diseases will infect the established collection. At this stage the seeds begin the initial drying and cooling process. The seeds are separated from the fruit and examined to ensure that insects and debris are removed. The room's temperature is kept at about 50 degrees Fahrenheit with low humidity to discourage mold and other fungi. This promotes the longevity of the seed and provides safe, short-term storage until the seeds can be used immediately for restoration or research activities or proceed to the National Tallgrass Prairie Seed Preparation Laboratory to be cleaned, packaged and frozen.



Workstations with central hall and displays beyond

Dixon National Tallgrass Prairie Seed Bank Preparation Laboratory

After seeds are collected and quarantined in the Seed Quarantine Chamber, they are brought into the Dixon National Tallgrass Prairie Seed Preparation Laboratory. Here, healthy seeds are separated from other plant material. The seeds are cleaned and analyzed for moisture content, weighed and counted. The room is isolated from the other rooms in the seed banking process and has an area with a fume hood to ensure that any contaminants are sequestered and filtered out. At this point, 25 seeds are sent to the Reproductive Biology Laboratory where they are germinated to ensure that they are viable. The remaining seeds are dried to 15 percent humidity and 58 degrees Fahrenheit. They are then carefully labeled and packaged in large, heat-sealed foil containers before being stored in the Dixon National Tallgrass Prairie Seed Bank at -20 degrees Celsius. From the field to the freezer, the process takes approximately six months.

Dixon National Tallgrass Prairie Seed Bank

The Seed Bank safely houses the seeds collected as part of a conservation project of the Chicago Botanic Garden aiming to collect and store the seeds of the tallgrass prairie region flora in over 1,000 square feet. Between 2003 and 2009, the Garden has committed to collect 20,000 seeds from 1,500 native species across the Midwest, with an emphasis on tallgrass prairies species, with the goal of conserving prairie plants before they become further imperiled. The goal of the seed banking project is global in scope. The National Tallgrass Prairie Seed Bank, in association with the national Seeds of Success program, is part of an international seed conservation initiative collectively known as the Millennium Seed Bank Project, originally developed by the Royal Botanic Gardens, Kew, United Kingdom. This global program aims to bank 10 percent of the world's flora by 2010 for long-term storage and conservation. Seed banking — conserving and storing species away from their original habitats — enables plants to escape threats imposed by destructive

Seed Bank Preparation Laboratory (dry lab) - processing of seeds for the seed bank habitat changes including urbanization, climate change, invasive species, overharvest, and pollution.

Reproductive Biology Laboratory

For a seed bank to be successful we must know how long seeds remain viable after they have been placed in the seed bank and we must understand conditions under which seeds germinate. This 700-square-foot lab is where scientists and graduate students will study such factors as seed germination, reproductive biology (pollination), and the quantity of seeds produced by different species. Here, scientists understand reproductive success and population stability in a number of rare and endangered plant species. Seeds can be germinated, grown and analyzed for genetic differences and viability. Samples of seeds stored in the Seed Bank are regularly tested to see that they will still germinate, and to determine the rate of decline of viability over time. If it is determined that viability has started to decline, the seeds are replaced with new collections. Alternatively, we take existing seeds out of the Seed Bank, grow them, harvest new seeds and replenish the seed bank collection.

Economic Botany Lab

The decline of biodiversity is of grave concern, and Garden scientists are actively researching how to minimize species loss and promote revitalization. When they map out the chemistry and assess the properties of selected plants, you receive the benefit of their work as new medicines and disease-resistant food plants eventually emerge. As part of this effort, economic botanists at the Garden are documenting the origin of specific uses of plants to aid in plant breeding programs and to develop strategies for the sustainable use of plant resources.

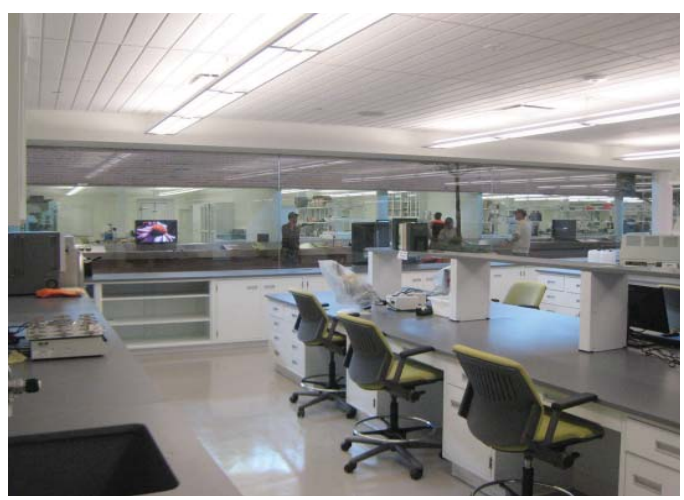
Economic Botany examines the complex relationship between plants and people. The field explores the cultural uses of plants to determine potential plants that could be exploited for medicines, industrial use, or new food crops; as well as to document the origin of specific uses of plants to add in plant breeding programs and to develop strategies for the sustainable use of plant resources. Economic botanists also investigate the chemistry of particular plants to assess the potential medicinal properties or economic benefits of selected species. Initial chemical screening can occur in this lab as part of collaborative research with major centers at universities and/or private and federal laboratories. New uses may be discovered from the plants we are conserving.

The Economic Botany Laboratory and the Plant Genetics Laboratory together are 2,000 square feet; the genetics lab contains specialized equipment, such as a DNA sequencer and centrifuge, for scientists incorporating molecular biology techniques into their research. Using this equipment, scientists in the Economic Botany Laboratory offer initial chemical screening as part of collaborative research with major centers at universities, or with private or federal laboratories.

Harris Family Foundation Plant Genetics Laboratory

As understanding of the molecular genetics of rare and endangered plants is gained, populations of these plants and the community that they grow in can be better managed and preserved. Researchers use a combination of molecular and quantitative techniques to better understand the level and distribution of genetic diversity within rare and endangered species.

The Plant Genetics Laboratory houses specialized equipment such as a DNA sequencer and centrifuge that will be used by graduate students, interns and scientists who utilize molecular biology techniques in their research.



View from lab through atrium and into laboratories beyond

Lenhardt Plant Science Library

The Lenhardt Plant Science Library houses primarily scientific journals and books. It includes an information desk, a large compact shelving unit, shelving on the outside walls under the windows, one work table for six, two computer stations, two lounge seats and a table. The space is 1,200 square feet.

Plant Science Library

Josephine P. & John J. Louis Foundation Green Roof Garden North and The Ellis Goodman Family Foundation Green Roof Garden South

Crowning the new Plant Conservation Science Center will be two green roof research living laboratory gardens. Each side of the roof has a demonstration garden representing the currently accepted best plants for roof top gardening. Additionally, each side is primarily an evaluation garden for green roof garden plants — a site for rigorously studying the adaptability of plants on a roof to ultimately increase the diversity of plants currently used in this extreme type of setting. Plants native to this region and elsewhere in North America will be studied. The roof study will provide scientists with research to understand the best materials and practices used in roof gardening and the extent to which a roof gardens can ameliorate air pollution, the urban heat island effect and nonpoint source pollution caused by storm water runoff.

Roof Garden

6. Project Facts

Building Name: **The Daniel F. and Ada L. Rice Plant Conservation Science Center**

Building area: **37,700 square feet (3,502.5 sq. meters)**

Building with site: **117,000 square feet (10,869.65 sq. meters)**

Total Cost: **$20,605,000 (building only) $28,925,800 (building, sitework, furniture, equipment)**

Cost per square meter: **$5,882/sq. meter ($547/sq. foot) building only; $2,661/ sq. meter ($247/ sq. foot) building, sitework, furniture, equipment**

Schedule: **Groundbreaking on June 3, 2008; Opened September 21, 2009**

Location: **Chicago Botanic Garden campus in Glencoe, Illinois, USA; Southeast area of the campus in floodplain**

LEED Certification: **USGBC LEED Gold- review pending**

Construction Facts

- 6,135 tons of gravel
- 13,800 cubic yards of earth moved
- 26.5 tons of rebar (approximately)
- 1,520 cubic yards of concrete (approximately)
- 3,619 linear feet of pipe
- 108,000 bricks
- 475 tons of structural steel, not counting decking and misc. steel stairs, etc.
- 10,054 square feet of curtain wall (exterior building material)

East Elevation

Mezzanine Conference Room connects to the naturalistic setting

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