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Environmentally Preferable Purchasing Program

Design for the Environment
U.S. EPA

Leading by Example

Two Case Studies Documenting How The Environmental Protection Agency Incorporated Environmental Features into New Buildings

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This document was prepared in a collaborative effort by two programs within EPA's Office of Pollution Prevention and Toxics—the Environmentally Preferable Purchasing (EPP) and Design for the Environment (DfE) programs. Each of the programs promotes the understanding that pollution prevention can best be accomplished at the beginning of an endeavor, from the decision to purchase or the initial design. The EPP and DfE programs have documented EPA's new building initiatives to demonstrate not only how federal buildings can be designed with environmental benefits, but also how purchasing decisions are an integral part of the sustainable design process.

Design for the Environment

EPA's Design for the Environment (DfE) Program helps businesses incorporate environmental considerations into the design and redesign of products, processes, and technical and management systems. DfE initiates voluntary partnerships with industry, universities, research institutions, public interest groups, and other government agencies.

Environmentally Preferable Purchasing Program

Environmentally preferable purchasing ensures that environmental considerations are included in purchasing decisions, along with traditional factors, such as product price and performance. The EPP program provides guidance for federal agencies to facilitate purchases of goods and services that pose fewer burdens on the environment.

For more information about either of these programs contact:
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We want to hear from you! Please tell us about your environmentally preferable purchasing activities and efforts. We are collecting and sharing information, tools, and hints about what works and what doesn't, as environmentally preferable purchasing evolves and expands. Please contact the EPP program by e-mail, regular mail, or fax:

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Acronyms

A/E	Architecture and Engineering
APA	American Plywood Association
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
DfE	Design for the Environment
DOE	Department of Energy
EPA	U.S. Environmental Protection Agency
EPP	Environmentally Preferable Purchasing
fc	Foot Candles
GSA	U.S. General Services Administration
GWP	Global Warming Potential
HCFC	Hydrochlorofluorocarbon
HOK	Hellmuth, Obata, and Kassabaum
HVAC	Heating, Venting, and Air Conditioning
IAQ	Indoor Air Quality
ICC	Interstate Commerce Commission
NAPCA	National Air Pollution Control Administration
NIEHS	National Institute of Environmental Health Sciences
ODP	Ozone Depletion Potential
RFP	Request for Proposal
RTP	Research Triangle Park
VE	Value Engineering
VOC	Volatile Organic Compound

Overview

The U.S. government is currently building two new facilities that together will provide working space for 9,000 EPA employees. Upon completion, they will be the U.S. Environmental Protection Agency's (EPA's) two largest facilities. The EPA headquarters facility will provide consolidated space in Washington, DC, for the Agency's 6,800 headquarters personnel. It currently includes space in the new Ronald Reagan Building and also will include space in several of the newly renovated buildings in the Federal Triangle complex. The second facility will provide laboratory and office space for 2,200 EPA scientists and other professionals in Research Triangle Park (RTP), North Carolina.

In keeping with its mission to protect the environment, EPA worked to ensure that designs for both facilities minimize adverse environmental impacts. Both facilities include features designed to protect indoor air quality, maximize energy efficiency, reduce water consumption, encourage alternative forms of transportation, and promote pollution prevention throughout the construction process. Design teams for both facilities also examined the environmental impacts of selected materials from a lifecycle perspective in an attempt to select products with minimal adverse effects, over time, to human health and the environment.

While the environmental goals for each of the facilities were similar, they were implemented differently because of key differences between the two projects. This document includes a case study for each of the EPA projects. Each details the decision-making process EPA used when selecting environmental design components.

Brief History of the Projects

When EPA was created in 1970, the first employees and their office space were inherited from many smaller agencies and subagencies subsumed by EPA. As EPA's regulatory, research, and pollution prevention responsibilities increased, EPA headquarters employees were located throughout the Washington, DC, area in 10 disparate locations. Similarly, many of EPA's research scientists were located throughout RTP in a dozen different buildings, some as many as 15 miles apart.

By the early to mid 1980s, the lack of a centralized headquarters facility was hampering Agency efficiency as employees constantly shuttled between buildings. It also hurt internal communication. There were similar concerns among the EPA employees in RTP. In addition, the numerous EPA laboratory facilities in RTP were aging rapidly and were no longer able to support all of the Agency's research needs.

EPA established headquarters and RTP teams to acquire new consolidated facilities. The efforts of each team and the specific history of each project are documented in the following case studies.

EPA's "Green Building Design" Initiative

In August 1995, EPA defined its "green buildings" vision and policy statement, in which green buildings were identified as "structures that incorporate the principles of sustainable design—design in which the impacts of a building on the environment will be minimal over the life-time of that building." EPA's green buildings statement identified 10 specific design objectives to achieve that goal. EPA also acknowledged, however, that some of the sustainable design goals might conflict with one another (increased ventilation versus increased energy efficiency, for example) or with other EPA objectives such as cost and function, or other policy goals such as environmental justice (with regards to site selection). For a complete copy of the EPA Green Buildings Vision and Policy Statement, see Appendix C.

In implementing these goals, EPA incorporated as many environmental features into the design of each of the new facilities as the budgets would allow without compromising building function. While several private sector and other nongovernmental organizations are beginning to incorporate environmental features like grey water recycling, solar, geothermal, and fuel cell power production, and straw bale construction, EPA only incorporated features that were appropriate within the context of the budget, construction process, building site, and existing infrastructures associated with each project. For example, both facilities had existing power plants as sources of heat. Developing completely new heating sources would have conflicted with each project's resource conservation goals and budgetary constraints.

EPA's intent was not to build facilities that showcase the latest emerging technologies or facilities that incorporate every "green" design option available. The goal was to design and build two functional facilities, each at a reasonable cost, and each with reduced adverse environmental impacts. Every design decision attempted to balance three guiding principles—function, cost, and environmental impact.

Key Differences Between the Projects

While the environmental goals for each of the projects are similar, there are fundamental differences between them—the number of decision-makers, EPA's level of involvement in the decision making process, and the building sites. These differences affected some of the decisions and the way in which they were made.

Number of Decision-Makers

The Agency's New Headquarters Project includes a new building—the Ronald Reagan Building, which will be occupied by EPA and other federal and private sector tenants—and renovations to existing buildings in the Federal Triangle complex, which will be occupied solely by EPA. All of the buildings, however, are owned by the U.S. General Services Administration (GSA). GSA is also managing the project, although GSA and EPA are working closely together to incorporate EPA's functional, cost, and environmental priorities. GSA must balance EPA's priorities with the overall project schedule and cost and with the functional and cost priorities of the other tenants.

Balancing competing building priorities required GSA, GSA's base building architects and contractors, EPA, EPA's interior architects and contractors, other building tenants, and federal employee unions to establish a framework to make many design decisions together. Consequently, the most challenging aspect of incorporating environmental considerations into EPA's new headquarters facility was developing an effective decision-making process. Consequently, the headquarters case study begins with a detailed examination of this process.

The RTP research complex, by comparison, included a more straightforward decision-making process. Unlike the headquarters project, EPA will not be leasing the facility from GSA. EPA will own the facility and will be its sole occupant. As a result, the RTP team was involved from the beginning of the project and was able to balance their own functional, cost, and environmental priorities without involving as many stakeholders.

EPA's Level of Involvement

EPA's involvement in designing the new headquarters facility occurred after a number of fundamental building decisions had been made, which restricted EPA's ability to affect the overall design. While a majority of EPA's opportunities to minimize the negative environmental impacts of the building affected the facility's interior because most of the building's skeleton design had already been completed, the Agency was able to influence some base building decisions, including the materials, mechanical systems, and water conservation features.

As the owner of the RTP facility, however, EPA had complete control over the design of the entire facility, from the location of the building on the existing federal property to the type of paint used on the interior walls. This provided EPA with a greater ability to affect the environmental impacts of the RTP facility.

These differences are reflected in the focus of the two case studies. The headquarters case study addresses many interior building concerns as well as some base building issues, while the RTP case study addresses the entire project.

Building Sites

The building sites for each of the new EPA facilities are very different. The headquarters facility is located in a historically significant block of downtown Washington, DC. The RTP laboratory facility is being constructed on a heavily wooded, 132.5-acre site that is part of a larger 500-acre federal property. While both projects were designed to minimize site impact, the opportunities to do so were different for each facility. In Washington, DC, the construction site included several historically significant buildings—minimizing impact meant preserving the historical significance of the site. In RTP, minimizing site impact meant preserving the forest, wetlands, wildlife habitats, and the existing watershed.

Significance of the Case Studies

These case studies not only demonstrate the feasibility of cost-effectively incorporating environmental concerns into large building projects, but demonstrate that the environmental concerns and the methods used to address them are likely to differ from project to project. They also demonstrate that the negative environmental impacts of a building can be minimized whether it is owned or leased, renovated or new, or located in an urban or rural setting. EPA's Design for the Environment (DfE) and Environmentally Preferable Purchasing (EPP) programs hope that the lessons learned from EPA's experiences with these two projects will help others incorporate environmental considerations into future buildings.

Case Study One:

EPA's Federal Triangle Headquarters Project In Washington, DC

Introduction

EPA has had a long-standing housing dilemma. Since its inception in 1970, EPA has experienced significant growth in both programmatic responsibility and personnel. EPA managers recognized that they needed to plan for a new, consolidated headquarters. In the late 1980s, the Agency assembled a group of key individuals (the EPA New Headquarters Project) to manage the housing effort and develop standards for environmental design, beginning with employee protection and ultimately including global environmental concerns.

As planning continued, the problem of disparate, scattered locations worsened. By the mid-1990s, EPA had rented space in 10 locations throughout the District of Columbia and Virginia. Some of these facilities represented departures from their intended uses. As a result, EPA's efforts to integrate and run efficient programs met with difficulties that included:

- Duplication and inequity of support services.
- Inefficient, costly, and often inappropriate use of space.
- Lack of centralized services.
- Overcrowding.
- Excessive operating costs caused by adjustments made for multiple sites (e.g.., multiple guard services, shuttle services, etc.).
- Environmental problems, which potentially have affected employees' health, created excessive long-term costs, and attracted considerable negative public attention.

EPA's goal was to consolidate its thousands of employees in a well-planned central location that offered greater efficiency, comfort, safety, and lower operating costs, while maintaining consistency with its environmental mission. In addition, a government-owned facility would save taxpayers rental expense. Large urban facilities with the appropriate features are not easy to locate, however, and it took many years of planning before EPA finalized plans for a new headquarters site at the Federal Triangle location in central Washington, DC.

In December 1993, the GSA Administrator announced plans for EPA to move into the Federal Triangle area, saying, "One of the major goals in this administration has been to consolidate and streamline our federal government. With this agreement, we have solved a long-standing problem that has spanned at least three administrations. In doing so, we give EPA the tools to carry out its critical mission, we reduce the number of federal office buildings, and we expect to save the taxpayers money through reduced leasing costs. Everybody wins."

EPA employees began moving into the new headquarters space in 1994. Move-in of all staff is expected to be completed by early 2001. About 6,800 EPA staff will work in the Federal Triangle area.

Stakeholders

A project of this size, importance, and complexity has many stakeholders, all of whom have to be able to coordinate and communicate their goals, needs, difficulties, and activities on an ongoing basis. Communicating effectively with so many people over several years poses an enormous challenge. The stakeholders for the EPA New Headquarters Project include:

- EPA's headquarters personnel.
- Gruzen Samton/The Croxton Collaborative, EPA's space planning and design architectural team.
- Staff members of EPA's Safety, Health, and Environmental Management Division.
- Other technical reviewers from EPA divisions with specific mission-related expertise.
- The National Federation of Federal Employees and the American Federation of Government Employees, unions that represent about two-thirds of EPA employees.
- The GSA-EPA team, which includes the staff of the EPA New Headquarters Project.
- The two GSA Project Executives in charge of this work.
- The Federal Triangle Consortium, GSA's developer for the Ronald Reagan base building.
- RTKL Associates, GSA's architect for renovations.
- All those interested in developing federal properties that are a value to the taxpayers.

The Buildings of the New Headquarters Project

The Federal Triangle site is one of the most valuable pieces of property in the federal government's inventory. Located in downtown Washington, DC, between Pennsylvania and Constitution Avenues, and 12th and 14th Streets, the area contains the last major unfinished site on Pennsylvania Avenue. Nearby are Freedom Plaza, the Willard Hotel, the National Theater, the Warner Theater, and the Old Post Office Pavilion. Before construction began on the Ronald Reagan Building, the site was a surface parking lot for over 50 years.

EPA's current housing plan involves the newly constructed Ronald Reagan Building and several historically significant New Deal-era buildings, including the Ariel Rios, U.S. Customs, and Interstate Commerce Commission (ICC) Buildings.

▼ *The U.S. Customs, Connecting Wing (containing the Mellon Auditorium), and ICC Buildings (left to right)*

Federal Triangle Project Time Line

1970	EPA is created.
1970	EPA's Washington, DC, headquarters staff occupies Waterside Mall Towers.
1971 to 1997	EPA headquarters continues to expand, eventually occupying 10 sites in the Washington, DC, area.
1981	EPA begins planning for a consolidated headquarters.
1987	Congress approves legislation for the creation of the Federal Triangle Building (renamed the Ronald Reagan Building in 1995).
1988	EPA New Headquarters Project team forms and begins talking with GSA about headquarters consolidation.
1991	Excavation and construction begins on the Ronald Reagan Building.
1993	GSA announces that EPA will occupy Ariel Rios, U.S. Customs, ICC, and Connecting Wing Buildings of the Federal Triangle Complex.
1993	GSA publishes Request for Qualifications for renovation of Federal Triangle buildings.
1993	RTKL Associates (GSA) and Gruzen Samton/Croxton Collaborative (EPA) are hired and planning for renovations begins.
1993	President Clinton signs Executive Order 12873: *Federal Acquisition, Recycling, and Waste Prevention*.
1994 to 1996	EPA moves into previously renovated Ariel Rios-South.
1995	EPA issues *Guidance on Acquisition of Environmentally Preferable Products and Services*
1995	GSA completes Prospectus Development Study for renovations.
1995	Planning begins for renovations to Ariel Rios-North.
1997	EPA moves into a portion of the Ronald Reagan Building.
1999	EPA moves into Ariel Rios-North (expected).
2000	EPA moves into ICC Building (expected).
2000 to 2001	EPA moves into U.S. Customs Building and Connecting Wing (expected).

New Construction: The Ronald Reagan Building

The design of the Ronald Reagan Building, although modern in function, blends with the classic Revival style of the buildings on site. The gracious exterior is covered with limestone from the same quarry that covers the older structures. The most notable architectural feature of the building is a 6-story glass and steel atrium that provides generous public space for restaurants, shops, and conference rooms. The facility, designed by the world renowned architectural firm of Pei-Cobb-Freed, is the second largest federal office complex, after the Pentagon.

▲ *Ronald Reagan Building*

The interior space of the building totals 3.1 million occupiable square feet. Approximately 1,000 EPA employees are presently occupying the 200,000 square feet that comprises EPA's portion of the building. The U.S. Customs Service and the U.S. Agency for International Development will occupy another 1.1 million square feet of space in this building. In addition, 500,000 square feet have been reserved for the International Cultural and Trade Center, which is being leased by commercial trade-related organizations. Finally, the Woodrow Wilson International Center for Scholars will occupy 50,000 square feet.

Approval and funding for this building was granted by Congress in the late 1980s, and construction of the "base building"[1] began before EPA was named a tenant in the project. EPA, therefore, had a somewhat limited role in the construction of the base building, although the Agency, working closely with GSA, had some modest successes in altering the building to reflect a number of sustainable design and mission features, including the addition of operable windows, use of low-Volatile Organic Compounds (VOC) paints in the base building, selection of a 4-phenyl cyclohexene (4-PC) free carpet buildingwide, incorporation of low-flow plumbing devices, use of fly ash in the cement, and a number of mechanical system improvements that contribute to a better indoor environment.

When designing its own interior "tenant" spaces, the Agency had much more latitude to reflect technical and environmental features. EPA's tenant spaces include such features as:

- Energy-efficient pendant lighting with up and down light distribution.

[1]"Base building" is a construction and architectural term that usually refers to work that is done to the external walls and foundation of a building. GSA uses this term in a different context than would a typical developer to indicate all the aspects of construction that GSA manages (versus those areas controlled by a tenant). GSA generally tries to put as much of the work as possible into the base building, and to leave little for tenant fit-out, partly because often no tenants have yet rented the space. This allows for more efficient and cost-effective design and construction. Aspects of a construction project that usually fall into the "base building" category include heating, ventilation, and air conditioning (HVAC); plumbing; electricity; exteriors; and construction of common areas.

- A "Green Lights" approach that reduces energy consumption.
- Fully equipped Haworth workstations that meet EPA mission and functional needs.
- Carpet tiles, aired out off site prior to installation, containing no 4-PC.
- Long-wearing, cleanable wall covering, applied with low-VOC adhesive.
- Low VOC paint.
- Durable fabric wall covering for conference rooms.
- Ceiling tiles with high recycled content.
- Compact fluorescent fixtures.
- Crystalline silica-free joint compound.
- Mechanical system refinements including direct exhaust of copy and pantry areas.

Buildings To Undergo Renovation: "Testaments to the American Spirit"

In addition to the new Ronald Reagan Building, the Federal Triangle site includes several buildings constructed during the Great Depression that "were intended to be testaments to the resilience and strength of the American Spirit," according to GSA's lead architect for the renovation. The renovated buildings include the following:

The Ariel Rios Building: The striking exterior architecture of this half-moon shaped building enabled EPA to establish a meaningful "front door." The interior public spaces include elaborate architectural details. The South Wing already had been renovated when EPA inherited the space in 1993 from the U.S. Department of Justice, and the North Wing is slated for renovations between 1997 and 1999.

The ICC Building: This building has a rectangular plan, with a central open light court extending to the basement floor and an octagonal rotunda. Many elegant historic spaces will be preserved and protected.

The U.S. Customs Building: This rectangular building, which forms a mirror image of the ICC Building, has a central open light court. A water fountain is centered in the court floor, around which extend formal walkways and landscaped

▼ *The front promenade of the Ariel Rios North building*

gardens. As is the case with the ICC Building, many historic spaces will be preserved and adapted for modern tenants.

Connecting Wing: This structure connects the U.S. Customs Building and the ICC Building. The elaborate three-story Andrew W. Mellon Auditorium faces Constitution Avenue and includes a large departmental auditorium, a spacious entrance lobby, and meeting rooms. Office space is located behind the auditorium.

In their original form, these buildings were very inefficient by today's standards, because their designers were working with an entirely different set of standards and needs. Built in an era with no mechanical air conditioning, the buildings contained narrow office spaces off a central corridor. Slatted "louvered" doors and transoms provided ventilation and return air to corridors. In essence, the corridors became return air plenums used for ventilation. The EPA New Headquarters Project faced a challenging job in upgrading the facilities to meet the needs of a technologically focused modern agency with a conspicuous environmental mission.

To meet historic preservation requirements, GSA had to preserve the original structures and appearance of many publicly accessible parts of these buildings, especially hallways, atria, many conference rooms, and some offices, as well as building exteriors. These structures are all listed on the National Register of Historic Places and in the GSA National Capital Region Historic Properties Inventory. The construction methods, architectural details, and materials—granite, marble, black walnut, bronze—have become irreplaceable. These buildings are viewed as national treasures and GSA had a strong commitment to restoring them in a historically sympathetic way and to displaying their important and historic contributions to federal government. All requested changes to the buildings were approved by the GSA Regional Historic Preservation Office and conform to the Secretary of the Interior's Standards for renovation of historic properties.

The New Headquarters Team and the Planning And Design Process

GSA owns and manages many federal buildings in the United States, including the Federal Triangle complex. It also manages all construction and design projects for its properties. GSA usually oversees such projects alone, partly because there are often no tenants for a space when the construction is being planned, but also because it is GSA's role to manage architectural and engineering projects for the federal government. In the case of the older buildings in EPA's new headquarters, however, GSA decided to proceed somewhat differently. According to one of the GSA Project Executives, "Given the complexity and public impact of EPA's consolidation effort, we realized from the outset that a different approach was required to manage all planning, design, construction, and move processes of the renovated buildings. We understood that EPA had to be an integral part of that team."

Differences To Be Overcome

The EPA and GSA team's overall objectives included: (1) planning for a headquarters facility that would meet EPA's functional needs now and in the future; (2) reflecting EPA's environmental mission in the facilities; (3) adhering to historic preservation mandates; (4) completing the move on schedule; and (5) ensuring project continuity from planning through occupancy. When the team first began to work together in 1993, however, some significant differences in concepts, operating style, and procedures existed between EPA and GSA:

- GSA set forth baseline design guidelines for federal construction and renovation projects in a document called PQ 100.1. These guidelines, at times, did not reflect EPA's specific environmental and technical requirements.
- GSA often focuses only on "first costs," meaning that it considers primarily the cost to purchase a product or system. EPA, on the other hand, considers "lifecycle costs"—the total costs of a product or system over its useful life—as a more realistic method of justifying investments in environmentally preferable items or features that better meet EPA technical performance levels.
- GSA's organizational structure typically separates construction from operations and maintenance, which makes it difficult to capture both operational and construction cost savings.
- GSA's standard process involves obtaining at least three bids from U.S. sources for every purchase used in a federal project, a process that works well for established systems and products that have mature markets. Conversely, some of EPA's environmental goals for the new headquarters focused on newly developed materials and systems, for which markets may not have developed fully. In such cases, the three-bid approach can be difficult or impossible to implement and thus inhibited the purchase of a material or system suggested by EPA.
- EPA's mission and historical problems with indoor air quality (IAQ) meant it needed to ensure the best possible IAQ for its employees. While GSA has extensive expertise in building construction and management, EPA believed

that its environmental expertise made it better suited than GSA to oversee its IAQ concerns.

Developing a New Process for Decision-Making

To address these differences, the agencies first had to set in place a new system of communication, which involved a different process of decision-making than had typically been used in past GSA construction projects (there are also differences in the process as it relates to the Ronald Reagan Building versus the renovated buildings; see inset next page). EPA and GSA eventually worked out a process that was collaborative, practical, and sensitive to the pressures of time and budget, while incorporating EPA's mission and technical requirements. The system included the following elements:

- A formal offsite partnering session was conducted for each of the renovation projects, to break down communication barriers and to develop a mutual understanding of project goals.
- To help EPA plan for a headquarters that truly reflected its environmental mission and achieved its goals for efficient operations, EPA chose an architectural group with environmental expertise, Gruzen Samton/Croxton Collaborative, to work on the renovations.
- Project managers at both EPA and GSA led the team and worked together closely.
- Frequent team meetings were held to discuss plans, to design layouts, status, and schedule, and to make decisions by consensus. The team discussed the merits of approaches, materials, systems, and processes and made decisions that satisfied the team as a whole.
- The team reviewed the design plans at several stages during development, which helped team members understand critical issues and improve procedures for the rest of the project. Design review involved "value engineering," which analyzes systems while paying special attention to the overall value of each decision. This process helped GSA and EPA prioritize their needs and stay within the fixed Congressional budget for the renovations.
- Stakeholders received regular communications (newsletters, automated voice announcements, etc.) to update them on the progress of the project and to ask for their input on specific issues.
- EPA backed up its commitment to environmental requirements by putting Agency resources into each project.

New Construction (Ronald Reagan Building) Versus Renovation Projects

The process of planning and constructing the Ronald Reagan Building differed from that of the renovated buildings in several ways:

- Because EPA will not be the sole tenant of the Ronald Reagan Building and was not involved in the project from its inception, EPA had fewer opportunities to comment on or modify the design for the new construction. For the buildings to be renovated, however, none of this groundwork had been laid, and GSA invited EPA to be a design partner from the outset. Also, EPA will be the sole tenant of all the renovated buildings.
- Because of its late entry into the design process of the Ronald Reagan Building, EPA's architectural firm was not a part of GSA's design team. For the renovation portion of the project, however, EPA did bring its own architectural firm into the design process at the start of planning. This early involvement enabled the team to incorporate features that were important to EPA into the building design.
- The Ronald Reagan Building design and construction project was managed by a private development corporation, whereas the renovated buildings were traditional GSA "design and build" projects. In the latter process, GSA itself manages the project and has direct control over design and construction. Thus, GSA can modify, refine, or add to the design, the materials, or the construction process as needed to meet the needs of its tenants.
- The Ronald Reagan Building was not subject to historic preservation requirements because it is a completely new building, whereas the buildings slated for renovation were subject to them.
- Presidential Executive Order 12873, signed in October, 1993, affected the renovation projects because it includes the environmental aspects of construction, renovation, and office furnishings. GSA was not required to consider environmental attributes in construction or purchasing of materials for the Ronald Reagan Building, however, because it was approved prior to the Executive Order.

Step-By-Step Decision-Making

To ensure EPA's needs were met in the planning, design, construction, and renovation of the new facilities, the team set up a series of important steps to implement for each building in the Federal Triangle complex.

Technical Building Assessments

Information related to the architectural, mechanical, structural, and electrical aspects of the buildings was reviewed by the EPA and GSA team, including:

- Assessment of power, heating, ventilating and air conditioning, lighting, structure, and telecommunications issues.

- Architectural analysis of the space.
- Environmental assessment of existing conditions in the renovated structures, including asbestos, lead, lighting, electromagnetic fields, and energy efficiency.
- Analysis of historic preservation requirements, which strongly influenced building modifications and use of space.

Refining EPA's Requirements

In 1988, the project team developed a comprehensive *Pre-Design Master Study* that defined EPA's facility requirements for the project. Both the baseline for design and EPA's architectural firm selection were dependent upon this study and a variety of other materials. Gruzen Samton/Croxton Collaborative then worked with EPA to specify state-of-the-art sustainable design and construction principles and to determine which principles were appropriate for use in this project, in the context of the available space and potential impacts on the projected completion schedule. The team then developed guidelines for building design and construction processes, and source selection criteria for design and construction materials, as well as interior furnishings.

These guidelines laid the foundation for the team to incorporate changes to the typical GSA design management processes. The team at times considered purchases with higher-than-usual initial costs, for example, if they could be justified by a short payback period. GSA required EPA payment for all items deemed beyond their standard building treatment.

▼ *A lobby in the Ronald Reagan Building*

Space Planning

Careful space planning required attention to the many programmatic divisions within EPA, as well as to the various individual needs of employees (e.g., facilities for conferencing, meetings, training, documents, child care, infant nursing, fitness, eating, and research). Decisions regarding the types, sizes, and relative locations of spaces needed had to be made early in the planning process. The team subsequently established detailed space use and environmental criteria. At this point, the team made specific decisions about equipment, layouts, materials, furnishings, and other details. The planning process required communication with relevant stakeholders about their needs.

The various EPA offices were distributed to reflect the functional organization of EPA. Program offices were consolidated physically and placed near one another to facilitate interaction. Since these programs all interface with the public, their offices were located to facilitate public communication and interaction. The

Executive, Legal, and Resource organizations were placed in Ariel Rios-North, near the offices that relate functionally to the work of the Administrator. Also, throughout the buildings, support functions were arranged so that they will be directly accessible to the individuals needing their services.

Planned Move Coordination

The process of constructing space and moving several thousand federal employees from multiple locations, already underway, will take more than seven years to complete. In addition, significant programmatic changes within EPA have affected the Agency's physical space needs; these have had to be incorporated into the design on an ongoing basis. Such a massive move requires precise planning and the involvement of representatives from the different EPA facilities and programs.

Communication and Outreach

In an organization so dispersed both physically and programmatically, a variety of communication mechanisms about the project had to be implemented throughout the duration of the project, including:

- An automated informational phone line with regular recorded updates that allows callers to talk directly to an EPA New Headquarters Project staff person.
- Numerous physical and photographic displays about the new facilities,which were placed at various locations around the current headquarters at Waterside Mall and at the Agency's satellite buildings.
- Electronic communications posted to EPA bulletin boards and on the EPA intranet, as well as regular office briefings.
- A demonstration area that displayed two typical workstations and interior furnishings for the new headquarters.
- A video about the new facilities, produced by the New Headquarters Project team and available for private and group viewings.
- Regular newsletters and fact sheets about the status of the project in the different buildings.
- Surveys of the needs and relative importance to EPA staff of various aspects of the move and the new facilities.
- Regular briefings for all EPA employees.
- A Program Committee, which includes representatives who exchange relevant planning information.

▲ *An office entrance-way in the Ronald Reagan Building*

Space Design, Materials Guidelines, and Project Management Considerations

The design approach taken with EPA's new headquarters complex addressed concerns of paramount importance to the Agency: functional organization of the various Agency components; efficient utilization of available space; recognition of employee health, safety, and comfort considerations; a workplace whose design embraces the Agency's mission goals and meets EPA's technical and program needs; and implementation of these objectives within the constraints of existing structures, budget, and historical preservation limitations. In some cases, EPA was able to assist GSA in implementing major design modifications and construction procedures to meet the Agency's mission and technical objectives. In other cases, only incremental improvements were feasible because of budgetary and historic preservation constraints.

Indoor Air Quality

EPA ranks poor IAQ as one of our nation's greatest health risk issues. IAQ may have considerable impacts on employee productivity and absenteeism, and may affect the general well-being of occupants. Members of EPA's design team established IAQ recommendations for GSA, concentrating on three categories: sources of emissions, mechanical systems design, and management of construction and renovation processes. These recommendations were developed with the primary goal of protecting EPA's employees from IAQ problems that might result from material selection decisions, as well as from construction and renovation activities. Additional considerations for selecting certain materials (joint and spackling compounds and floor and base moldings) were the health impacts on workers during manufacturing and construction activities and the effects created when materials ultimately make their way into the waste stream.

Managing Sources of Emissions

The EPA and GSA design team developed and implemented a number of source control procedures. These focused on using construction materials that exhibited a low potential for chemical emissions (called "off-gassing potential"), including low-emitting carpeting, paints, adhesives, insulation materials, and general construction materials. The EPA and GSA team took steps to avoid building materials and products containing high levels of VOCs and toxic chemicals. Members of EPA's Safety, Health, and Environmental Management Division and specialists from EPA's design team played a critical role in reviewing material safety data sheets of key materials and products used by GSA's contractors and making recommendations. The general guidelines developed by EPA to meet its IAQ source management goals follow.

Paints and Coatings

Emissions from paints and coatings may contribute greatly to IAQ problems. Some paints and coatings contain volatile petroleum-based solvents, fungicides, and biocides, as well as crystalline silica and heavy metals[2]. Although off-gassing of these volatile substances is considerably more dramatic during application and drying periods, it continues to a lesser degree after application. Oil-based paints tend to off-gas a greater level of VOCs on initial application than do water-based paints. Properly selected paints and coatings, handled with correct precautions, do not contribute significantly to IAQ problems.

EPA suggested guidelines for low-VOC paints and coatings, a number of which are available for interior wall and ceiling surfaces. EPA also identified low-VOC caulking, sealants, adhesives, wood finishes, and waterproofing materials. The team also recommended that these paints be applied under maximum ventilation, which should be continued for at least 72 hours following completion of work.

Carpets ready for air-out before installation

Carpets

An earlier agreement between EPA employee unions and management required that all carpeting used in EPA facilities must be free of the chemical compound 4-PC, an odorous compound that had been associated with prior EPA indoor air complaints. Additionally, to ensure that the new carpeting would not contribute to IAQ problems, a number of other steps were taken. Carpeting for all EPA spaces was aired out (i.e., carpet tiles were removed from packaging and spread

[2] Crystalline silica and heavy metals can become airborne occupational hazards for construction workers as a result of sanding and scraping old paint during renovation activities. They can also become an IAQ hazard for building occupants if the ventilation duct work is not properly cleaned after all sanding and scraping is completed.

out) for seven days at another location prior to installation in EPA space. Carpet tile was installed using four dots of glue in each corner of the tile rather than covering the entire surface with glue, as is traditional. Guidelines also required that all finish painting and sealant applications be applied and fully cured prior to carpet installation, to prevent absorption and subsequent re-emission of off-gassed chemicals in carpeting. Lastly, the contractor monitored a 21-day flush-out period after the carpets were installed and prior to tenant move-in. During this time, the HVAC system was run 24 hours a day, with the goal of using 100 percent outside air to completely flush the interior air.

Flooring and Base Moldings

Many flooring and base molding products contain vinyl chloride monomer, a known human carcinogen.[3] The EPA technical team noted that vinyl chloride exposure associated with flooring and base molding most likely occurs during the manufacturing of these products. In addition, vinyl chloride can be a problem in waste incineration. The team, therefore, suggested that rubber-based materials be substituted for the vinyl-based molding, and that linoleum tile be substituted for vinyl composition tile. In addition, adhesives low in VOCs were used during application, with maximum ventilation provided during and immediately after installation.

Joint and Spackling Compounds

Joint and spackling compounds commonly contain hardening agents, such as crystalline silica. These agents do not necessarily pose a hazard during application, but can become inhalable dusts as a result of sanding or other renovation activities. Construction workers continually exposed to these airborne dusts without proper respiratory protection can also develop lung irritations and even silicosis. Further, it is possible for silica dusts to be introduced into a building's mechanical system during construction or renovation activities.

In response to these issues, an alternative joint compound that did not contain a crystalline silica component was identified and used during construction of EPA space in the Ronald Reagan Building.

▼ An Assistant Administrator's suite in the Ronald Reagan Building

[3] Health Effects Assessment Summary Tables, Office of Research and Development, Office of Emergency and Remedial Response, U.S. EPA, 1995.

This product costs approximately the same amount as traditional silica-containing joint compound, but it required construction workers to hand-mix the ingredients on site. Choosing appropriate materials often provides valuable lessons for future products. In a number of locations throughout the Ronald Reagan Building, imprecise mixing caused the compound to crack upon drying and required additional repair work. Steps were taken to avoid these problems in subsequent applications.

Plywood and Particle Board

Urea formaldehyde resin is often used as a bonding agent in plywood and particle board. Formaldehyde, a probable human carcinogen and chemical irritant, is known to off-gas at room temperature for extended periods of time in bonded products. To reduce this potential source of indoor pollutants, the EPA team suggested that exterior grade plywood be used as one alternative in exposed interior applications, such as telephone closets and cabinetry. Large-scale chamber tests documented by the American Plywood Association (APA) found concentrations of formaldehyde from exterior grade plywood, which uses phenolic formaldehyde resin, to be less than 0.1 parts per million (ppm) under APA standard test conditions.

Furniture

Volatile chemicals, such as formaldehyde, are often used in the sealants and glues found in indoor office furniture and have the potential to off-gas during the life of the furniture. To identify products that would minimize this potential source of indoor air pollutants, EPA developed chemical emissions criteria and a testing program for furniture vendors who wanted to participate in EPA's bidding process. In 1990, the State of Washington published its furniture procurement standards, which many furniture manufacturers now use as a baseline for their production processes. Based on this program, the EPA team developed even stricter threshold values for chemical emissions off-gassing from furniture for the new headquarters project:

- Maximum formaldehyde concentration in air — less than 0.05 ppm
- Maximum aldehyde concentration in air — less than 0.1 ppm
- Total VOC concentration in air — less than 0.5 milligrams per cubic meter
- 4-PC (as an odorant) — below the limits of detection

Furniture testing was coordinated by the EPA team and GSA's National Furniture Center, working with a nationally recognized laboratory in Marietta, Georgia. EPA conducted and documented inspections of manufacturing sites and the furniture testing facility to ensure compliance with the established testing procedures. All testing was done in compliance with EPA's quality assurance and quality control procedures.

Reinventing Furniture Procurement

Traditionally, federal purchasing decisions are based on cost and performance. To address human and ecological risks as well, EPA developed and implemented a voluntary environmental assessment checklist for furniture manufacturers. This tool was used to assess the environmental policies in place at each manufacturer's facilities, in addition to the environmental characteristics of systems furniture submitted for consideration under this procurement. First, environmental performance and characteristics of the workstation were considered, including energy conservation, IAQ, and resource conservation (i.e., use of recycled and recyclable materials). Second, the assessment reviewed the vendors' overall environmental sensitivity and corporate environmental and occupational health policies, including pollution control and strategies for energy and resource conservation and worker health and safety.

EPA was not necessarily attempting to identify the "greenest vendor." EPA preferred, however, that the selected vendor demonstrate due diligence in a broad fashion relative to environmental, sustainability, and ergonomic issues that advance and support EPA's mission. Scoring for this procedure was not competitive, and vendors were not required to have addressed every issue. A cumulative score resulted in a pass or fail for this section of the assessment.

Haworth Inc. of Holland, Michigan, the furniture manufacturer selected to supply furniture for EPA's new headquarters, followed a number of positive corporate environmental practices, including:

- Using energy-efficient task lighting in systems furniture and being a corporate partner for EPA's Green Lights program.
- Constructing and packaging systems furniture using recycled and recyclable materials.
- Designing workstation furniture panels so they could be refurbished and reused.
- Using water-based adhesives, high-solid paints, and other low-VOC technologies.
- Avoiding the use of chlorofluorocarbons and hydrochlorofluorocarbons (HCFCs) in insulation materials.
- Participating in EPA's WasteWi$e and 33/50 voluntary corporate pollution prevention programs.

The furniture procurement process for the New Headquarters Project clearly demonstrated that the federal government's purchasing power can be a positive influence on the private sector. In addition to providing a higher measure of protection for EPA employees from furniture emissions, the use of the emissions test and vendor checklist sends a message to potential vendors that corporate practices and manufacturing processes compatible with EPA's goals are valued and rewarded in the federal procurement process. As EPA's Project Manager stated, "This was a noteworthy procurement given that there were no regulatory requirements driving the process. Basically, it demonstrates that the federal government can have a tremendously positive influence in the private sector by merely exercising its purchasing power and that the marketplace is willing to embrace such an effort."

The development of this testing program has had positive pollution prevention results. One manufacturer, for example, reevaluated a chair and changed its manufacturing process to avoid using urea formaldehyde. This production change occurred within 30 days after the chair failed EPA's emissions test, even though this manufacturer knew at the time that the chair would not be selected by EPA. As a result of the success of this testing approach, GSA plans to make a similar process available for other federal agencies, thereby expanding GSA procurement selection beyond traditional technical and cost criteria to include emissions factors. The consideration of environmental factors, (e.g., emissions values) along with more traditional factors, is a core concept of EPA's Environmentally Preferable Purchasing and Design for the Environment programs.

Mechanical Systems Design

The EPA and GSA team also reviewed design drawings for the mechanical systems at Federal Triangle, to ensure that the quality of ventilated air would be adequate to protect employee health and that air intakes were properly located to avoid cross-contamination from building exhausts. To accomplish this, the separation between exhausts and intakes was set to exceed American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) code minimum distances by a substantial amount. EPA also worked with GSA to ensure that copy rooms, pantries, parking garages, toilet rooms, and commercial cooking facilities were designed with independent exhausts to prevent recirculation of degraded air. For these areas, air is exhausted on the roof, away from general building ventilation air intakes.

Additional measures related to the mechanical system that have been or will be implemented in these structures to ensure sound IAQ include:

- Incorporating carbon monoxide and nitrogen oxide sensors at air handlers in interior areas of concern, such as garages and lower floors of buildings, to ensure proper ventilation.
- Installing an electronic HVAC management system in the Ronald Reagan Building, which allows for sophisticated monitoring, ease of maintenance, automatic adjustments for seasonal differences in heating and cooling needs, and warnings to building staff if adverse air quality conditions develop.
- Using filters on all air handling units to remove up to 85 percent of particles.
- Supplying a minimum of 20 cubic feet of ventilated outside air per minute, per occupant.
- Installing or retrofitting windows so they are operable in the event of mechanical system failure.
- Testing all building systems to ensure that they are operating as designed prior to occupancy, including operation of the ventilation system at maximum fresh air for seven days.

The design team also evaluated GSA's guidelines for the refrigeration systems, which were based on extreme weather conditions. By running a Department of Energy (DOE) computer model (DOE-2), Gruzen-Samton/Croxton Collaborative and RTKL determined that chiller capacity would be under-utilized, resulting in inefficient energy use. The design team replaced the configuration of one large chiller with a series of seven smaller centrifugal chillers. This configuration maintained the capacity for extremely hot conditions, but also allowed for more efficient use of chillers when high capacity was not necessary. In addition, building managers can extend a chiller's useful life by rotating it in and out of use. Space in the refrigeration plant was created for a spare chiller, which can be rotated into use when one of the installed units needs servicing or retiring.

The EPA and GSA team also identified factors to consider in reviewing refrigerant and chiller equipment options: global warming potential (GWP) and ozone depletion potential (ODP) of refrigerants,[4] toxicity of refrigerants, size of equipment desired (defined by the size of the equipment room), ultimate phase-out date for refrigerant if applicable, and cost. Early in the planning process, hydrofluorocarbon 134a (HFC 134a), a chlorine-free alternative to HCFC 123, was identified as a "cutting edge" refrigerant because it had no ODP and a low GWP. Equipment manufacturers later demonstrated to EPA, however, that HCFC 123 could be used in conjunction with state-of-the-art chillers in a configuration that would produce a higher level of energy efficiency, relatively low ODP, and a lower GWP than HFC 134a. Other factors that were considered include HCFC 123's higher acute toxicity and pending phase-out date of 2030, which was not significant to the decision mainly because the expected useful life of the chillers was rated at less than 30 years. Given similar costs for the two refrigerants, these factors influenced the EPA and GSA team to decide upon HCFC 123. The lesson learned in this project is that a refrigerant decision calculus involves a complex matrix of factors, and the appropriate refrigerant choice cannot be driven by a single consideration.

Construction Management

An important aspect of ensuring IAQ for the EPA and GSA team was to protect employees occupying completed spaces adjacent to areas and buildings during construction and renovation. Team members were especially concerned about the build-up of construction particles, odors, VOCs and combustion particles from construction activities (e.g., welding, painting, and carpeting), and disruptions to the HVAC systems during partial tenant occupation. The EPA and GSA team developed guidelines (see box) to reduce the potential emissions produced during construction by managing and mitigating activities that temporarily produced airborne dust, odor, and other contaminants.

Team members conducted regular walk-throughs of the EPA construction areas to ensure compliance with specified materials, installation methods, and construction practices.

[4] ODP = capacity for a chemical to deplete the stratospheric ozone layer relative to CFC 11; GWP= capacity for a chemical to retain heat in the lower atmosphere relative to carbon dioxide.

EPA Applied Construction Management Guidelines
Maintaining IAQ in Tenant Spaces

Housekeeping:

- Avoid the use of methylene chloride-based paint removers in renovated areas.
- Lay temporary carpets in EPA space over newer carpets to avoid tracking dusts and particulates from other parts of the work site into renovated and furbished areas; vacuum temporary carpets weekly to avoid contaminant buildup.
- Continuously monitor construction areas to avoid buildup or accumulation of moisture that could contaminate construction and interior materials.
- Establish onsite storage areas for volatile materials and temporary staging areas for waste materials.
- Isolate and protect occupants in completed spaces from construction activities using differential pressure and solid barriers between construction areas and tenant spaces.
- Locate paint lockers away from tenant spaces.

HVAC System:

- Isolate shared air handlers for space under construction from occupied tenant spaces.
- Add supplemental prefilters to all outside air intakes supplying occupied areas.
- Inspect and change filters in air handlers more frequently during phased construction and occupancy.
- Clean return air plenums prior to phased occupancy.
- Provide minimum air flow of 20 cubic feet per minute per person for all occupied space.
- Direct exhaust of construction floors and areas to the exterior of the building.
- Provide additional temporary ventilation during construction activities that affect IAQ (e.g., painting and use of solvents and glues).
- Rebalance building ventilation system prior to all phased tenant move-in.

Work Scheduling:

- Complete interior wet work (e.g., painting) and other processes prior to installing absorbent products (e.g., carpets, systems furniture, and ceiling tile) to avoid buildup of dust and odors.
- Schedule work when it is least likely to disrupt tenant work (e.g.,through noise).
- Use EPA and GSA team members' work site visits to ensure that IAQ protection processes are being followed.

Energy and Resource Conservation

"Green Lights" Design

EPA's Green Lights[5] approach to lighting design is featured prominently in the Federal Triangle Project. The overall goal of EPA's lighting design was to utilize a combination of natural, pendant, and task lighting to maximize energy efficiency and maintain a properly illuminated work environment for employees. Adequate daylight creates a healthier and more stimulating office environment, which leads to improved staff morale, health, and productivity. GSA accommodated EPA's technological requirements within the constraints of historic mandates in the spaces undergoing renovation.

▲ *Natural, pendant, and task lighting illuminate office space in the Ronald Reagan Building*

EPA tenant spaces were designed to enhance the flow of natural and artificial light, including the following innovations:

- Raised the height of drop ceilings in the Ronald Reagan Building to take advantage of additional natural lighting ("daylighting").
- Maintained high ceilings in renovated spaces to enhance spatial openness and daylighting.
- Kept partitions, office support spaces (e.g., copy rooms), and mechanical rooms to the interior of the Ronald Reagan Building, to maximize penetration of daylight into employee work spaces.
- Added glass sidelights around doors and clerestory windows (glass openings at the tops of walls) to increase the amount of natural light that reaches the interior of the building.
- Selected workstation colors that maximize light reflection.

Bidirectional pendant (hanging) lighting fixtures that use energy-conserving fluorescent tubes and ballasts were installed. These fixtures use energy-efficient T-8 triphosphor-coated light bulbs, parabolic reflectors, and electronic ballasts. Pendant lighting is very efficient (up to 90 percent), providing about 60 percent indirect and 40 percent direct lighting. Lighting the ceilings, as well as the spaces below, diminishes glare, dispels shadows, and creates an impression of daylight deeper into the building.

EPA also worked with GSA to devise an energy-saving strategy allowing them to reduce the ambient lighting from the GSA standard of 50 foot candles (fc) per person to 30 fc, with workstation task lighting supplying the remaining 20 fc. Occupancy sensors installed in every workstation were preset to turn off workstation lights auto-

[5] EPA's Green Lights is a voluntary program that encourages the widespread use of energy-efficient lighting systems. Information about the program can be obtained by calling 202 775-6650. The web site can be reached at www.epa.gov/greenlights.html.

matically whenever the workstation remains unoccupied for 15 minutes. In addition, daylighting controls and floorwide occupancy sensors ensure that general space lighting also turns off when not needed. All these features increase energy efficiency while meeting GSA requirements.

Additional Energy and Resource Efficiency Features

Creating energy-efficient space was an important priority of the EPA and GSA design team. Low-flow plumbing devices were installed in faucets and toilets. Also, more than 2,000 historic windows in the renovated buildings, many of which are at least 5 by 9 feet in size, were fitted with weatherstripping and double glazing. In addition, interior storm windows with thermal breaks were added. These features enabled the buildings to retain the original architecture, while greatly increasing energy efficiency.

Recycling and Reuse of Materials

An important aspect of the modernization portions of the project was the reuse of the existing structures, which supported both the historic preservation and sustainable design objectives. This choice saved an estimated 75,000 tons of concrete, 6,000 tons of steel, 100,000 square feet of glass, and 3,000 tons of masonry. In addition, it reduced the use of new building materials and the overburdening of landfills with demolition waste. Although historic preservation was the fundamental reason for choosing to restore the several buildings at the Federal Triangle Complex, the final result promotes resource conservation in the building industry.

The EPA and GSA team also identified a number of opportunities to procure materials with recycled content. Suggested materials included gypsum wallboard, ceramic and stoneware tile, steel and aluminum, roofing felt, and concrete containing fly ash from municipal solid waste incineration facilities. If such materials could be guaranteed to deliver comparable performance at an acceptable price and at least three U.S. sources existed for the product, GSA was often able to purchase the suggested material.

The furniture manufacturer supplying the EPA space in the Federal Triangle Project used a construction and packing system that included recycled materials. Additionally, the panels used in office partitions were designed for a “take-back” program, so that they could be returned to the manufacturer for refurbishing as needed.

The Federal Triangle Project, like any construction and renovation project, generates waste. Severe space limitations at this construction site limited the extent of waste separation for recycling. Additionally, much of the waste material from the older buildings contains lead-based paint and/or asbestos, and regulations designed to protect public health limit the recyclability of such materials.

Transportation

Parking space in downtown Washington, DC, is at a premium. Several bus lines, as well as the Washington, DC, Metro system (subway), have stops at Federal Triangle. Although a parking lot was incorporated into the design of the Ronald Reagan Building, competition for spaces is high.

▲ *Metro entrance outside of the Ariel Rios building*

EPA will continue its policy of subsidizing a portion of the cost of public transportation for its employees. EPA has also secured space in the Ronald Reagan Building basement to store bicycles and has provided lockers and showers for employees. These features encourage employees to use alternative transportation modes rather than driving, thereby helping prevent pollution and conserving resources in accordance with EPA's mission.

Lessons Learned

This last section focuses on the EPA and GSA members of EPA's consolidation project team, exploring what these individuals consider to be the most important lessons they learned during their many years of collaboration. EPA hopes that the sustainable building design principles and procedures outlined in this document and the reflections of team members shared below will be valuable to others working on renovation and new construction projects in both the public and private sectors.

Early Involvement

EPA's New Headquarters Project team was set up in 1988, almost immediately after Congress approved funds for the Ronald Reagan Building. From the beginning, the EPA Project Manager envisioned this team as requiring the active participation of all stakeholders. EPA's architectural group, Gruzen Samton/Croxton Collaborative, composed of firms with sustainable design experience, was brought into the team when EPA was offered the buildings in the Federal Triangle site.

Because of their very different missions, styles, and processes, EPA and GSA were starting from dissimilar perspectives and needed to build trust and good communication in order to work together effectively. One of the environmental architects and planners with Gruzen Samton/Croxton Collaborative, said, "We were involved with the renovation projects practically from day one, and I cannot stress enough how important that is. You get a better product when you are involved early in the process. Especially with a complex project like this one—that involved so many environmental issues with significant consequences—it was critical that we were able to start at the very beginning and build trust gradually with all the team players."

Teamwork

According to one of the GSA Project Executives, "The success of a project depends on how well the team works. There is nothing more important. The renovations of GSA's historical buildings at Federal Triangle require intense cooperation and constant communication among members of the team. The success of this project means that GSA will definitely be more open to future dialogues with our tenant agencies." EPA's Project Manager echoed this sentiment, saying, "A good partnership between landlord and tenant is particularly critical to an efficient and successful building project. When everyone who is important to the outcome is included on the team and they respect and listen to each other, the results can be outstanding."

Be Prepared To Learn

"One of the most interesting things I rediscovered during this project," said one of the GSA Project Executives, "is that there simply is no 'list of best things'—sustainable products or otherwise—to be incorporated in a project. The needs are different each time, and they have to be worked out in the context of that specific project." One of the architects concurred, "There are literally thousands of small decisions that had to be made during the course of the renovation projects, and because so many of them involved different materials and processes, we often couldn't rely on past experience to make them. Instead, we had to learn from each other and from the group's discussions."

Comprehensive, conclusive information is rarely available about the health risks and other environmental impacts associated with a product or material. Typically, the project team is faced with fragmentary information of varying quality on a limited number of hazard and exposure parameters. The project team must make product selection decisions by applying its professional judgment to integrate the available information as best it can.

GSA and RTKL team members note that they will have a heightened awareness of sustainable design in the future. GSA's Project Executive for the Ronald Reagan Building said, "This project demonstrated that interagency collaboration can result in cost-effective decisions that are also environmentally sound."

The EPA Project Manager commented, "In just the past few years, sustainable design has been thoroughly mainstreamed into quality architectural design. Most architects now pay attention to designing 'for the environment.' What makes this aspect of designing so challenging and exciting is that it is still changing so rapidly, as manufacturers get involved and try new techniques and processes. This process has forced all of us to reexamine our conceptual paradigms."

One of the environmental architects with Gruzen Samton/Croxton Collaborative concluded, "I would hope that everyone who reads this case study comes away realizing that significant, economically and environmentally sound purchasing decisions can be implemented at every level of building design, demolition, renovation, and construction."

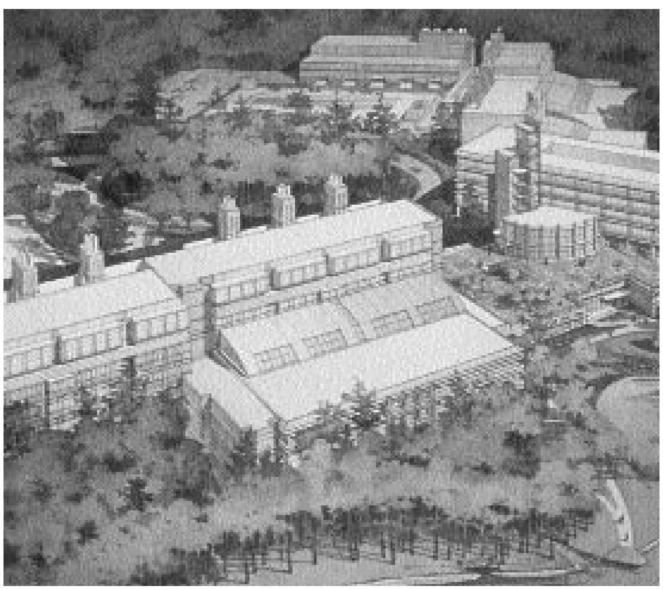
Case Study Two:

EPA's Office and Research Campus in Research Triangle Park, North Carolina

Introduction

EPA recently began constructing a new $250 million, one-million square-foot laboratory and office complex in Research Triangle Park (RTP), North Carolina—EPA's largest complex outside of Washington, DC. In addition to housing EPA employees and scientists who work to protect the environment, the building was designed to minimize its environmental impact. The design incorporates a wide variety of environmental features, including:

- Protecting indoor air quality (IAQ).
- Maximizing energy efficiency.
- Incorporating the use of recycled-content materials and other building materials with environmental attributes.
- Reducing the environmental impacts of parking and transportation.
- Promoting recycling, resource conservation, and pollution prevention throughout the design and construction phases.
- Minimizing the building's impact on the site by reducing the excavation required, reducing the number of trees and amount of vegetation removed from the site, and protecting the existing watershed.



▲ **An artist's rendering of the RTP facility**

The process used to incorporate environmental attributes into the building are as important as the attributes themselves. EPA and Hellmuth, Obata and Kassabaum (HOK), the architecture and engineering (A/E) firm that designed the facility, examined the environmental impact of every aspect of the building's design before decisions were finalized. These aspects included, for example, the size and location of the building, the materials and processes used to construct it, and building maintenance and operation. Nearly every building attribute was examined for its function, environmental impact, and cost throughout every phase of the building design process. To provide additional technical expertise during the extensive design reviews, EPA partnered with GSA and the U.S. Army Corps of Engineers. The result is a building that will meet or exceed all of EPA's functional needs while minimizing costs and adverse environmental impacts.

Although design work began in 1992, before EPA issued its *Guidance on Acquisition of Environmentally Preferable Products and Services*, the design process incorporated many of the objectives described in the *Guidance*. As a result, this design and construction project provides a valuable model for how other agencies can integrate environmental preferability into their purchasing decisions, even acquisitions as large as a quarter-of-a-billion-dollar building. This case study documents EPA's decision-making process, how it was applied throughout the design phase, the results of those decisions, and the lessons learned.

Building Description

▲ *A model of the National Computer Center*

The RTP laboratory and office complex is located on 132.5 acres of a 500-acre federal property that includes a 23-acre lake and the laboratory facilities for the National Institute of Environmental Health Sciences (NIEHS). The building site rises along gently sloping terrain and peaks 60 feet higher in elevation than the lake. It consists primarily of second growth forest, which is less than 50 years old. The site also contains several groves of old-growth trees, including one that contains a 100-year-old oak tree that is 11 feet around.

The one-million-gross-square-foot EPA facility includes 635,000 net square feet of office and laboratory space for 2,200 EPA employees. The main facility consists of four five-story laboratory buildings, connected by three 30-foot-wide atria to three three-story office buildings. The main building also includes a central five-story office tower that contains a cafeteria, conference center, several auditoriums, and a library. A high-bay engineering research wing is connected to the southern end of the complex. The laboratory and office buildings are situated alongside the lake so that they follow the curve of the shore. The EPA National Computer Center and a jointly operated EPA/NIEHS child care facility are located on another part of the EPA campus, less than a quarter of a mile away.

Project History

Background

EPA's current RTP laboratory facilities include a dozen outmoded, rented facilities dispersed throughout a 15-mile area in three counties. The main facility, described by one EPA employee as "an eclectic hodge-podge of wings and labs," was built by the National Air Pollution Control Administration (NAPCA) as an interim facility. EPA inherited the building when President Nixon established EPA in 1970, and NAPCA was subsumed within the newly created agency. A sign on a fence outside the building still reads, "NAPCA Interim Facility." The building was intended to be a short-term measure until EPA could build a permanent, centralized laboratory complex.

Budget considerations prevented immediate construction, but as EPA's responsibilities grew, so did the need for a modern, centralized laboratory complex. In 1987, EPA began seeking Congressional funding to build a new facility. An Army Corps of Engineers' estimate at that time suggested that the time lost as EPA employees shuttled among the existing buildings cost EPA almost $3 million a year. There

EPA's Research Triangle Park Operations

The new EPA facility will house the Office of Research and Development, which investigates the effects of a variety of pollutants on human health and the environment. Its work provides the scientific basis for many of EPA's regulatory and policy decisions.

The RTP facility will also house the Office of Air Quality Planning and Standards, which is tasked with implementing the Clean Air Act. In addition, the facility will include EPA's National Computer Center and a number of crucial administrative groups.

are also significant costs associated with continually retrofitting existing space to make it suitable for EPA research, costs that will be avoided in a new facility. EPA estimates that the new facility will pay for itself in 22 years.

In 1991, Congress gave EPA $5 million to begin designing the new facility[6] and the following year EPA selected HOK to design it. The design was completed in 1996. By 1997, Congress had appropriated funds to initiate construction. Ground was broken in July 1997, and the $272 million project is expected to be completed by early 2001.

EPA's Design Team

Although EPA has extensive expertise in numerous environmental arenas, the RTP facility is one of the Agency's only major building projects. As a result, EPA looked to other government agencies for assistance with the design and construction plans. Within the federal government, GSA and the U.S. Army Corps of Engineers have the most construction project experience, and both provided EPA with valuable assistance.

Project Time Line

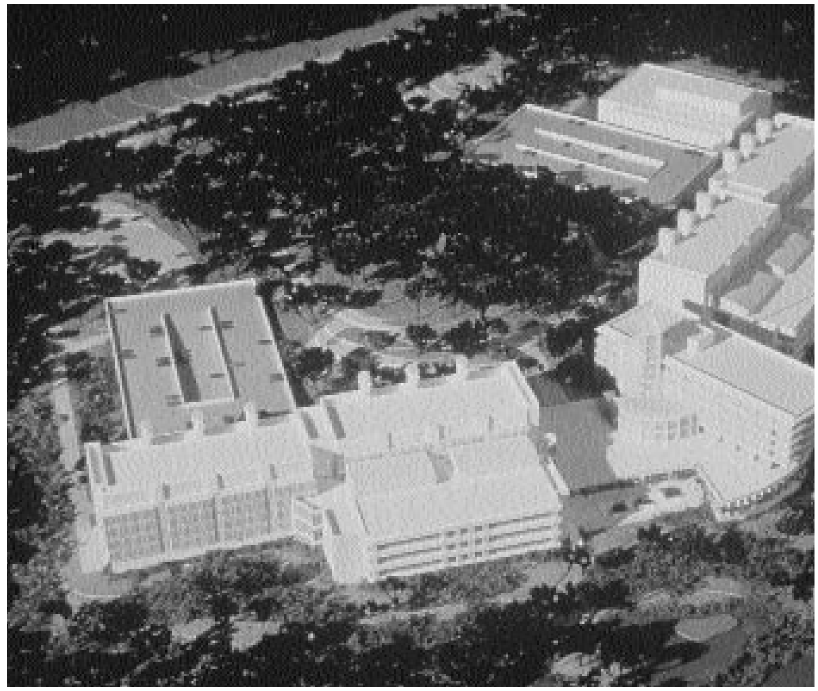
1970	EPA is founded and begins conducting research in several Research Triangle Park laboratories.
1970 to 1997	EPA expands its research capabilities, eventually occupying a dozen rented buildings in the Research Triangle Park area.
1987	EPA seeks Congressional permission to build a new research facility.
1991	Congress gives EPA $5 million to begin design; it was incrementally increased to $20 million.
1992	Hellmuth, Obata and Kassabaum are selected to design the new facility.
1996	Facility design is finalized.
1997	Congress appropriates $110 million to initiate construction.
1997	Clark Construction Group begins construction on the new facility.
2001	Construction is completed and facility is occupied (expected).

GSA brought extensive experience acquiring, designing, and constructing new and rented federal facilities to the EPA building project. GSA provided an experienced architect who became the lead government architect on the EPA team. The GSA architect participated in all design reviews, ensured that the facility complied with all necessary government standards, and made substantial improvements and contributions to the final design.

[6] Between 1991 and 1996, Congress incrementally increased design funding to $20 million.

Through an interagency agreement, GSA is also managing construction of the EPA facility. GSA is ensuring that construction remains on schedule, on budget, and within the contract specification requirements.

The Army Corps of Engineers provided specialized engineering expertise throughout the design process, including a team of design experts that led EPA and the design team through the value engineering (VE) process. VE is an industry-accepted design practice intended to save money by identifying design changes that will provide the same function at a reduced cost. Outside experts are brought in to critique the partially completed design and to offer design alternatives. Typically, the VE process only examines function and cost, but EPA, HOK, GSA, and the Corps of Engineers also emphasized environmental factors in their design reviews. The Corps of Engineers VE team led design reviews when the design was 35, 65, and 95 percent complete, and the results produced significant cost savings and environmental improvements, including:



▲ *A model showing a view of the facility from the west*

- Removing the curb and gutter from the surface parking lots and using natural biofiltration to handle storm water runoff. Innovative "bioretention" facilities were added to enhance the natural system by using porous zones planted with trees, shrubs, and herbs that absorb and break down contaminants from heavy rains. The total cost of the bioretention system was less than conventional approaches and will improve environmental performance because less construction materials will be required and water filtration will be improved.
- Reducing dramatically the size of the access road from a four-lane divided highway with wide utility cuts to a simple two-lane road with electric lines under the pavement. This will significantly reduce the cost of building and maintaining the road and will preserve an additional 20 or more acres of trees. In addition, road and utility rights of way will be planted with indigenous trees and wild flowers. The indigenous vegetation will not require fertilizer or frequent mowing, which will significantly reduce the pollution concerns resulting from those activities. In addition, landscaping with native species plants allowed the designers to remove plans for an underground irrigation system, which will save additional building costs.

As follow up to their design role, the U.S. Army Corps of Engineers has also agreed to serve as a technical advisor to EPA and GSA during the construction of the RTP facility.

Selecting the A/E Firm

Following normal government procedure, EPA issued a standard Request For Proposal (RFP) announcing a need for design and engineering services to design a new laboratory and office complex. The RFP contained several environmental design requirements, including experience maximizing energy conservation, indoor air quality, and pollution prevention. Over 80 firms submitted proposals and EPA narrowed them to six companies based on the specific factors listed in the RFP. Each of the final six companies was interviewed in depth about their capabilities to meet EPA's design needs. Following the interviews, EPA selected HOK as the winning design firm.

Specifying Design Objectives

The EPA and HOK design teams identified eight design goals. The design for the facility, in order of importance, was required to be:

- Functional
- Environmentally friendly
- Easily maintained
- Brightly illuminated with natural light
- Able to facilitate and promote communication between EPA employees
- Of flexible design that permits modifications to handle future EPA needs
- Within walking distance of parking
- Secure

EPA asked the designers to incorporate as many environmental features into the new facility as the budget and existing technologies allowed, without compromising its function as a state-of-the-art research facility or exceeding the construction budget. EPA also asked that the facility's environmental attributes:

- Protect IAQ by selecting materials with minimal adverse IAQ impacts and by establishing maximum indoor air concentrations for several indoor pollutants.
- Conserve energy, water, and building materials by designing a highly resource-efficient facility that maximizes utility while minimizing required space.
- Promote recycling and pollution prevention through the use of materials with identifiable environmental attributes. These included recycled-content materials, materials from sustainably managed forests, and materials that minimize negative environmental impacts throughout their entire life cycles, including low-energy use during production, local availability, low toxicity, high durability, and similar environmental attributes.
- Preserve the natural environment by minimizing the building's impact on the site, including reducing the amount of excavation required, decreasing the number of trees cleared from the site, protecting the onsite wetlands, creek, and lake, and preventing a need for intensive grounds maintenance following building occupancy.

According to the EPA Project Manager, breaking with tradition was one of the most difficult aspects of the project. He explained that, although a commitment from the entire team was essential, "at first, a number of the team members had to be dragged kicking and screaming into the green design discussions." EPA and HOK project leaders encouraged all of the architects and engineers to go beyond their traditional emphases on function, cost, and aesthetics to incorporate environmental concerns into the design process. "Many government team members also struggled with the constant focus on 'green design,'" according to the EPA Project Manager, "because traditional engineering approaches were being challenged and there was constant pressure to live within a limited budget."

Environmental Design Features

EPA asked the design firm to incorporate environmentally preferable features as part of the building's design that would:

- Protect indoor air quality
- Conserve energy, water, and building materials
- Promote recycling and pollution prevention
- Preserve the natural environment

Once the commitment to environmental design was fully established among all of the partners on the design team—EPA, GSA, the Army Corps of Engineers, HOK and all of their consultants—the designers, according to the EPA Project Manager, "took the ball and ran with it." EPA formed a pollution prevention advisory group that included scientists and engineers from within the Agency. Several of these experts stayed with the project through design completion. GSA and the Corps of Engineers also tapped resources throughout their agencies to help identify design solutions that were functional, cost-effective, and environmentally sound.

HOK actively participated in EPA's pollution prevention brainstorming sessions and design evaluation sessions, and made use of many of the ideas and concepts generated by the government team members. HOK also went much further, building upon its existing environmental credentials. One of the firm's lead architects on the EPA facility explained that "[Environmental design] issues are incredibly important and HOK is trying to integrate them as broadly as possible with our clients and throughout the construction industry."

Decision Process: Function, Environment, and Cost

Even more impressive than the actual design for the facility is the decision process that was used to incorporate environmental attributes throughout it. Every aspect of the facility's design, construction, and operation was examined for its environmental impact and balanced against the associated effects on building function and cost. EPA and the A/E firm discussed these three attributes—function, environment, and cost—before each major design decision throughout the five year design phase. The result, according to the EPA Project Manager, produced a facility that "may not be [environmentally] perfect, but it is a long way from where it would have been and a lot closer to where all buildings should be."

The interplay between function, environment, and cost are evident in the decisions affecting:

- Building materials selection
- Material conservation
- IAQ standards

- Energy and water conservation features
- Features and practices that promote recycling
- Efforts to protect the natural environment

Material Selection

> *"You can make anything green if you throw enough money at it. The challenge is to do it within the existing budget."*
>
> *EPA Project Manager*

One of the attributes of a "green" building is that it is built with "green" materials. As part of the design process, EPA worked closely with HOK to select building materials that have multiple positive environmental attributes. They looked for products that, throughout the life cycle (production, installation, operation, and disposal), included the following attributes:

- Consume minimal nonrenewable resources
- Require reduced amounts of energy
- Produce minimal pollutants
- Contain recycled or recyclable materials

HOK produced and conducted a product survey that asked manufacturers and vendors to provide information on the environmental impacts of their products throughout the products' full life cycle. The survey addressed raw materials (including recycled content percentages); production processes; packaging and shipping; installation and use; recyclability; impact on IAQ; and general information about cost, life expectancy, maintenance requirements, and availability. The information was compiled in a database and was used by the EPA design team and HOK to analyze materials before they were incorporated into the facility's design. The resulting database, HOK's *Healthy and Sustainable Building Materials Database*, currently includes information gathered from over 600 manufacturers on over 1,000 products. Each entry includes a "green score" that is based on the information in the database. (For additional information, see the resource list in Appendix D.)

Working closely with HOK, EPA established minimum recycled content and maximum volatile organic compound (VOC) content levels for numerous materials and HOK used them to identify and select appropriate building materials. (See Appendices A and B for additional information.) The content levels were designed to promote the use of products with positive environmental attributes without eliminating competition. For example, eliminating VOCs in paint is generally a preferable environmental characteristic, but only a few manufacturers produce paint with zero VOCs. Many more manufacturers, however, produce paints with less than 150 grams of VOC per liter, which by present standards is still very low. (GSA's VOC-content specification for virgin latex paint, for example, currently requires no more than 250 grams of VOC per liter.) By establishing the VOC content level for paints at 150 grams per liter, EPA is helping to protect the environment and preserving competition, which, in addition to being required by federal law, is expected to yield more competitive prices.

Flooring Debate

For most building materials, it was relatively easy to select products that satisfied EPA's functional, environmental, and cost goals. Some materials, however, proved to be more challenging. One example was the selection of the floor covering for the labs. While cost, not environmental preferability, was the deciding factor in the final analysis, the team examined the environmental attributes of flooring materials before making that determination.

Laboratory floor coverings have to be particularly durable and chemical-resistant to withstand chemical spills. At least three materials can be used and were considered for this application: terrazzo, linoleum, and vinyl. Terrazzo is made from polished marble or granite, and the only substantive environmental impact appears to be from mining and transportation. Unfortunately, however, terrazzo is prohibitively expensive, especially considering the quantities needed for the EPA laboratories. As a result, terrazzo was eliminated from consideration before any detailed examination of its environmental impacts was conducted.

▲ *A simulation of a typical laboratory interior*

Once terrazzo was eliminated from consideration, the EPA design team and HOK examined the remaining two materials—linoleum and vinyl. Linoleum is frequently promoted as a "natural" product because it is manufactured from many renewable materials, including wood flour, pine rosin, linseed oil, and jute (a fiber obtained from a plant grown in India). While the use of sustainable raw materials is generally a positive environmental attribute, there are negative environmental consequences associated with some of the fertilizers used to produce them. At this time, linoleum is also only manufactured in Europe and requires significant resources for transportation to the United States.

Vinyl is a plastic polymer derived from oil and can be highly polluting during extraction, refinement, and manufacturing. It appears, however, to consume less energy and natural resources during production than linoleum and is available from several manufacturers in the United States, which reduces the energy used to transport it.

Using emission factors obtained from product literature and EPA's Indoor Environment Management Branch's IAQ model, EPA modeled the IAQ impacts for vinyl and linoleum. Under identical conditions, the predicted VOC concentrations were similar for each of the two floor coverings, so neither could be considered environmentally preferable from an IAQ perspective.

Based on the preliminary research comparing the environmental attributes of vinyl and linoleum, the design team could not definitively declare one environmentally preferable to the other for EPA's RTP facility. Doing so would require a more intensive and scientific examination of the entire life cycle for both products, a process that was prohibitively expensive and time consuming for EPA's immediate needs. As a result, EPA relied on cost as the determining factor and selected a vinyl floor covering for the EPA labs because it was significantly less expensive than linoleum.

Atrium Design

Another example of the multiple factors that were considered for each building component was the design of the building atria, among the most impressive features of the new EPA facility. Each of the three 30-foot-wide, three-story atria has several functions:

- Connects a laboratory and office building.
- Allows natural light to penetrate deep into the building.
- Reduces demand on the heating and air conditioning system by minimizing the external surface area of the building, which lowers overall heat loss and gain.
- Decreases the need for exterior precast concrete and thermal pane glass, which reduces costs and decreases resource consumption.
- Benefits IAQ by providing a large volume of preconditioned air that can be used in the laboratory buildings.
- Improves the aesthetics of the facility, thereby improving worker morale and productivity.

▼ *A model of the atrium interior connecting the lab and office wings*

The atria's benefits had to be balanced against their potential environmental and economic costs. An atrium, for example, can be difficult to cool in the summer because the sun's rays penetrate the glass and increase the temperature inside. It can also be equally difficult to heat in the winter because of the volume of air that must be heated. In order to successfully balance function, environmental impact, and cost, EPA decided to examine several different options. HOK used computer simulations to model six different options and compared fixed and operating cost, day lighting, thermal efficiencies, IAQ effects, and environmental impacts.

After comparing each of the six models, EPA and HOK determined that the most critical factor was the atrium's heat loss and gain because it affected the energy required to heat and cool the atrium. As a result, they selected an atrium design that incorporated alternating panes of energy efficient glass and Kalwall, a translucent material that allows light to enter, but minimizes heat transfer. Compared to an atrium containing 100 percent high-performance glass, the selected design will reduce operational costs by 66 percent without adversely affecting daylighting benefits, other functions, the environment, or procurement cost. Coincidentally, the selected atrium design not only provided the greatest energy savings, but also had the lowest construction cost, which helps disprove the common misperception that "building green" costs more.

Material Conservation

Even more important than using recycled content and other materials with environmental attributes is minimizing the amount of material needed. Several times, EPA's design team or HOK reexamined a design aspect to reduce the amount of construction materials needed as well as their associated costs. Three examples are the facility's access roads, the labs' interstitial space, and the flexible, modular interior office design.

> ***"What's the use in using recycled-content materials if you are building twice as much building as you need?"***
>
> ***EPA Project Manager***

Access Roads

The original master site plan included a four-lane divided road entering and exiting the EPA facility. The master plan also included a 20-foot wide utilities easement that paralleled the road. During the VE process, the design team questioned the need for so much roadway because of the significant quantity of paving and asphalt materials required, the large number of trees that would have to be cleared to accommodate it, and the cost.

After learning that there were no safety or traffic considerations to justify a four-lane divided road, EPA requested that it be redesigned as a simple two-lane road and that the necessary utilities be placed under the road rather than next to it. It was relatively easy to reduce the size of the road, but several engineers maintained that utilities always have to be placed beside the road because placing utilities under the road could severely disrupt traffic if any utilities needed to be repaired. EPA explained that the road was unique because it would primarily be used only during the early morning and late afternoon when EPA employees arrive at and leave work. Any necessary maintenance could occur throughout the workday without adversely affecting traffic flow. In addition, because there are two routes in and out of the facility, traffic can be rerouted if extensive repairs are necessary.

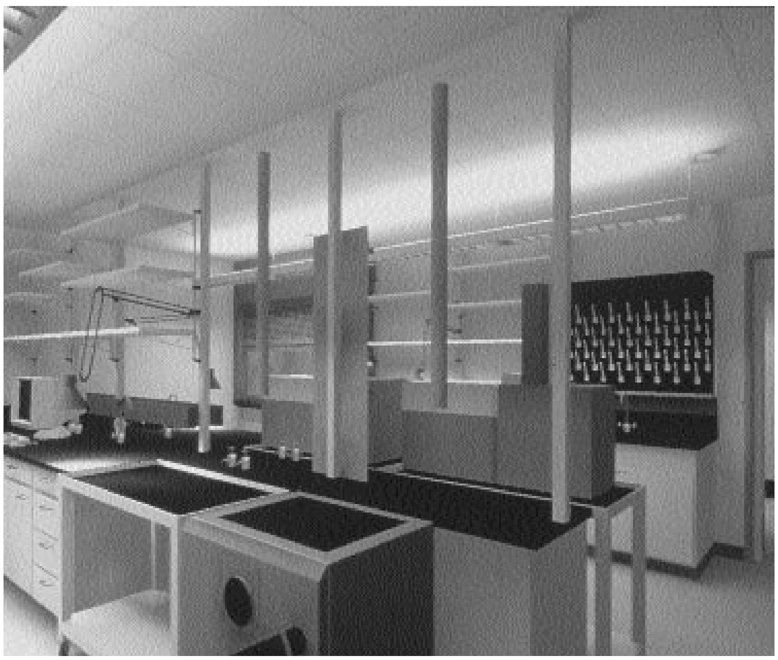
Reducing the size of the road from four lanes to two and placing the utilities under the road rather than next to it reduced the size of the clearing by over 75 feet, prevented over 20 acres of trees from being cleared, reduced by one-half the quantity of materials necessary to construct the road, and reduced the cost of the road by almost 50 percent.

Interstitial Space

Laboratory configurations are frequently rearranged to accommodate new experiments. As a result, many laboratories are designed with a corridor of space adjacent to them (known as interstitial space) that contains all of the gas, water, and ventilation piping as well as the electrical, computer, and laboratory equipment wiring. Such a configuration makes it easy to access the laboratory utilities and to rearrange laboratory setups for new experiments.

In many laboratory buildings, the interstitial space is located above each floor of laboratories. Consequently, a building with five laboratory floors must be 10 stories high to accommodate the interstitial space. This is considered by some lab designers to be the most flexible and serviceable configuration and was given early consideration for the RTP facility. EPA, however, asked the design firm to present space- and material-saving alternatives.

Instead of locating the interstitial space above each lab, HOK recommended placing it beside each lab. By designing service corridors rather than horizontal interstitial space—floors between floors—EPA avoided a potential 50 percent increase in building height, which would have added the rough equivalent of 100,000 square feet of space without increasing usable floor space. Minimizing the total volume of the building will have significant advantages, including reducing the cost and quantity of required construction materials. It also will reduce the load placed on the heating and air conditioning system, thereby saving energy and reducing heating and cooling costs.



▲ *A simulation of a double-bay laboratory interior*

Modular Design

Over the life of a building, interior space is typically renovated many times to meet changing needs. Each time interior space is reconfigured, however, waste is created and new materials are required. In an attempt to minimize the cost and environmental impacts of future renovation, HOK proposed a modular design that allows large portions of every floor to be easily reconfigured. When reconfiguration is necessary, the lights, sprinklers, electrical outlets, heating and air conditioning vents, and automated building sensors remain stationary. All that needs to move are the partitions that designate individual work spaces. The design, according to one of HOK's lead architects, allows EPA to "move people, not walls," and dramatically reduces the material and cost requirements for renovation.

Indoor Air Quality

The interplay between function, environment, and cost extends beyond building materials to entire building systems. One of the most critical of these systems attempts to optimize IAQ and energy efficiency. These two objectives, however, typically conflict—as one increases, the other decreases.

The easiest way to improve IAQ is to *increase* the volume of clean outside air circulating through a building. This drastically increases heating and cooling costs in most climates, including the part of North Carolina in which EPA's new facility is being built. Similarly, one of the largest energy drains on a building is the heating and air conditioning system. The easiest way to reduce the energy required to heat and cool a building is to *minimize* the volume of outside air entering the building. This reduction in outside air circulation usually lowers IAQ.

To address these competing demands, EPA worked closely with HOK to develop a 150-page *Indoor Air Quality Facilities Operation Manual* that documents the necessary IAQ procedures during building construction and maintenance. The manual outlines procedures to maximize both IAQ and energy efficiency by:

- Eliminating as many IAQ contaminants as possible.
- Increasing energy efficiency throughout the building to offset any reductions in energy efficiency due to the need to increase air circulation.

Eliminating IAQ Contaminants

EPA and the A/E firm worked to eliminate as many IAQ contaminants as possible. They accomplished this by specifying materials with minimal contaminants of concern that also met functional and cost requirements, establishing appropriate installation sequences to prevent IAQ contaminants from being absorbed into the building, requiring extensive IAQ testing before building occupancy, and incorporating design features to eliminate specific IAQ hazards following building occupancy.

Material Selection

The largest sources of potential IAQ contaminants are interior building materials, office furniture, and equipment. Interior building materials, including carpets, carpet padding, paints, sealants and caulking, glues, floor and ceiling tiles, cabinets, molding, composite wood products, and other wood work, can contain contaminants that are gradually emitted (off-gassed) throughout the life of the material. The contaminants include formaldehyde, 4-PC, other VOCs, and small particulate substances that act as eye or throat irritants. Additional IAQ contaminants can originate with office furniture, room dividers, and photocopiers (*Indoor Air Quality Facilities Operations Manual*, EPA Research and Administration Facility, July 1996).

Indoor Air Quality

IAQ can be affected by the order in which interior materials and finishes are installed. When possible, Type One materials will be allowed to dry before Type Two materials are installed.

Type One Materials:

- Composite wood products, specifically including particle board from which wood paneling, doors, or furniture may be fabricated.
- Adhesives, sealants, and glazing compounds.
- Wood preservatives, finishes, and paint.
- Control and/or expansion joint fillers.
- All hard finishes requiring adhesive installation.
- Gypsum board and associated finish processes.

Type Two "Fuzzy" Materials:[‡]

- Carpet and padding.
- Fabric wall covering.
- Exposed insulation.
- Acoustic ceiling materials.
- Fabric covered acoustic wall panels.
- Upholstered furnishings.

[†]Materials that may be categorized as both Type One and Type Two are considered Type One materials.

Before any material was specified for use in the building, it was examined for possible adverse affects on IAQ, in addition to its general environmental impact. If possible, products containing materials known to adversely affect IAQ were not specified. To further protect IAQ, the construction contract requires the contractor to test indoor paint, carpet, ceiling tiles, and fireproofing materials in an environmental chamber on an appropriate substrate, which is designed to simulate the actual application and materials interaction as much as possible. This testing will help ensure that the materials meet the design established for the facility by the EPA design team. Materials with contaminants of concern below the EPA-designated levels can be used throughout the facility. If a product exceeds EPA's designated levels, an alternative product will have to be selected.

Several EPA employees explained that, although it is not required, it might be in the contractor's best interest to test additional materials because the building must pass strict EPA-defined IAQ tests before occupancy. (See the section on testing below.)

Sequencing

IAQ is affected not only by the materials that are used but also by the order in which they are installed. Certain materials and finishes (Type One materials), off-gas potential indoor contaminants for a short duration after they are manufactured or installed. The contaminants off-gassed by Type One materials can be adsorbed by "fuzzy" materials and finishes (Type Two), which are woven, fibrous, or porous in nature. Type Two materials can become repositories for substances that can be released much later or that promote subsequent bacterial growth.

The construction contract specifies air exchange rates and proper air filtration procedures to ensure that whenever possible any necessary off-gassing from Type One materials is dissipated before Type Two materials are installed. These procedures prevent Type Two materials from adsorbing substances that might later reduce IAQ.

The contractor is also required to properly clean all duct work and replace all air filters before building occupancy.

Testing

After building construction is complete, but before EPA occupancy, the construction contractor is required to hire an independent IAQ consultant to test levels of indoor air contaminants to ensure that they are within EPA-specified requirements. The contractor will test 16 locations over three consecutive days throughout the building as directed by EPA with the building operating at normal ventilation rates. The average results will be used to determine compliance with contract IAQ requirements as defined in the table below.

Maximum Indoor Air Concentration Standards

Indoor Contaminants	Allowable Air Concentration Levels*
Carbon Monoxide (CO)	<9 ppm
Carbon Dioxide (CO2)	<800 ppm
Airborne Mold and Mildew	Simultaneous indoor and outdoor readings
Formaldehyde	<20 $\mu g/m^3$**
Total Volatile Organic Compounds (TVOC)	<200 $\mu g/m^3$**
4 Phenyl Cyclohexene (4-PC)***	<3 $\mu g/m^3$
Total Particulates (PM)	<20 $\mu g/m^3$
Regulated Pollutants	<National Ambient Air Quality Standards (NAAQS)
Other Pollutants	<5% of Treshhold Limit Value - Time Weighted Average (TLV-TWA)

* All levels must be achieved prior to acceptance of the building. The levels do not account for contributions from office furniture, occupants, and occupant activities.

** Above outside air concentrations.

*** 4-PC is an odorous contaminant constituent in carpets with styrene-butadiene-latex rubber (SBR).

If the building fails any EPA standards, the construction contractor must rectify the problem and retest the building at no additional expense to the government.

Exhaust Stacks

EPA was also concerned about potential IAQ concerns following building occupancy. One of the primary areas of concern was the exhaust gas from the EPA labs. The EPA laboratory complex includes 13 exhaust stacks—three on each of the four laboratory buildings and one on the high bay engineering research wing. Together, they vent exhausts from nearly 300 fume hoods. The exhaust stacks were originally designed to be 20 feet high and, although the primary fresh air intakes for the buildings will be located well away from the exhaust stacks, EPA officials questioned whether the stacks would be high enough to prevent potentially hazardous materials from recirculating into the building.

In order to determine if the stacks were tall enough, EPA had a 1:192 scale model of the buildings and site terrain constructed. EPA scientists placed the model in the EPA Meteorological Wind Tunnel where ethane gas was emitted from the model's exhaust stacks and its concentration measured at the model's fresh air intakes. Wind direction and speed were systematically varied in order to identify worst case scenarios.

The results indicated that there was some risk of exhaust reentry during certain wind conditions that occur with some frequency at the building site. The scientists increased the height of the exhaust stacks on the model and repeated the experiment to determine if it would reduce exhaust reentry. After completing the experiment, they concluded that increasing the stack height by 10 feet would improve IAQ by significantly reducing the potential for exhaust reentry at the fresh air intakes. Although the potential risk of exhaust reentry was minimal at the original 20-foot stack height, it was virtually eliminated at the 30-foot stack height.

As a result of the modeling, EPA decided to increase the height of the buildings' exhaust stacks from 20 to 30 feet. While the increase will require more material to construct the stacks, increasing the stack height will improve overall indoor air quality and should reduce required maintenance of filters at the air intakes.

Energy Conservation

Based on Department of Energy statistics for average energy use in laboratory and office buildings, the new EPA facility will use 42 percent less energy than the average laboratory and, depending on which building is being evaluated, between 52 and 64 percent less energy than the typical office building. These reductions in energy use are expected to save approximately $1.5 million a year when compared to facilities of similar size and function.

Energy conservation has been a focus of architects and engineers since the 1970's energy crisis. As a result, the EPA design team and HOK had numerous off-the-shelf energy conservation technologies and programs from which to choose, including several automated building systems and EPA's Green Lights program. In addition to off-the-shelf solutions, which were incorporated as needed throughout the facility, EPA and HOK also developed additional energy conservation solutions unique to the EPA facility.

Fume Hoods

There are nearly 300 fume hoods in the RTP laboratory complex. Fume hoods are vitally important to human health and safety in a laboratory environment because they provide well-ventilated areas in which to safely conduct experiments involving potentially hazardous substances. Unfortunately, fume hoods are not typically very energy-efficient because each contains a large exhaust fan that is used to ventilate the room at a rate of about 1,400 cubic feet a minute. In addition to the fans' energy consumption, fume hoods also decrease the efficiency of the ventilation system because, in the process of removing potentially hazardous fumes, they also remove the heat or air conditioning from the room.

The design team investigated options for increasing the efficiency of the fume hoods while continuing to maximize safety. One of the first things it examined was the need to have an exhaust fan for each fume hood. After consulting with the appropriate health and safety inspectors, the team designed an exhaust system with a centralized air flow control system that drastically reduces the number of fans. Instead of individual fans, plus backup fans, for each of the fume hoods, each laboratory wing is supported by a large collector plenum on the rooftop that pulls exhaust above the roof using only a few large, energy-efficient fans.

Each fume hood also has a specially designed sash that allows researchers to control the volume of air being removed. The sash can be opened fully to set up or change conditions in the hood, but can also be set to an 80 percent open position, which cuts air demand by 20 percent. In addition, the fume hoods are connected to the building automation system (BAS) [described below] so that if a scientist closes the sash, leaves the room and turns out the light, the fume hood's energy use will be 70 percent less than in its full-open position. Together these efforts increased the fume hoods' energy efficiency without reducing safety or IAQ.

Central Utility Plant

The EPA research facility, like other large office complexes, needs access to large volumes of hot and cold water for heating and cooling. While EPA could have built its own central utility plant, it instead chose to expand the natural gas-powered plant that currently serves the NIEHS building located nearby on the same 500-acre federal site. Expanding the existing plant will save money and, compared to building a new plant, will drastically reduce the cost and quantity of required materials.

Building Automation System

EPA selected an off-the-shelf BAS that will help maintain good IAQ and promote energy conservation. It will allow EPA operations staff to monitor and control whether ventilation fans are on or off, whether filters are clogged, when motors or pumps need to be repaired, and other energy consuming aspects of the building, including:

- Temperature, pressures, and humidity
- Electrical systems
- Refrigeration and boiler equipment
- Maintenance indicators and alarms
- Lighting, security, and communications

High-efficiency motors with variable speed drives will be programmed to operate only when necessary and only at the rate needed. When compared with constant speed drives, variable speed drives have a longer operational life and consume less energy. The BAS will also include variable air volume controls that will provide additional energy savings.

EPA Green Lights Program

EPA's Green Lights Program, established and maintained by EPA's Atmospheric Pollution Protection Division, was another off-the-shelf program that assisted the design team for the new EPA facility. The team incorporated several features identified by the Green Lights Program, including specifying high-efficiency lamps and ballasts, photoelectric dimming controls, a central lighting control system, extensive task lighting, and occupancy sensors that will turn off lights in unoccupied offices.

The design team also made extensive use of natural lighting throughout the building, including expansive windows and strict protection of open zones along the perimeter of the building that allow light to penetrate into interior offices. Interior doors with glass panels also help improve interior lighting.

Based on Department of Energy statistics for electricity consumption from lighting, adopting Green Light principles in the new EPA facility will reduce electricity consumption for lighting by 70 percent in the office buildings and 43 percent in the laboratory buildings compared with conventional designs, without adversely affecting lighting quality.

High-Performance Window Glazing

Increasing window area reduces the need for artificial lighting. While this reduces electricity consumption for lighting, it can also increase heating and cooling costs due to heat gain and loss through the windows. To minimize those costs, the A/E firm specified extensive use of spectrally selective tinted glass with an improved low E-coating that maximizes the amount of visible light entering the building, while minimizing the accompanying heat gains and losses.

Water Conservation

As with energy conservation, there are many off-the-shelf technologies to promote water conservation. EPA incorporated water-efficient fixtures throughout the facility, including flow-restricting nozzles, automated shutoff, and hot and cold water delivery systems with automatic temperature controls. The lavatories will have sensor operated metered faucets that regulate the amount of water flow, which will save water and the energy needed to heat it.

EPA also intends to minimize outdoor water use by landscaping with only native species plants that do not require routine watering.

Onsite Recycling

EPA and HOK designed the RTP complex to facilitate the occupants' recycling efforts. Designated recycling areas were created to accommodate the collection of paper, glass, aluminum, plastic, and cardboard. An underground service tunnel links the collection points to the main loading area. A designated composting area for landscape refuse is also located on the site.

Construction Management

While it is relatively easy to get their fellow EPA employees to recycle, the EPA design team also wanted to use the new facility as a model for promoting recycling, source reduction, and pollution prevention throughout the building industry.

Requiring the Contractor To Recycle

Typically, contractors dispose of most of their construction debris by placing it in large dumpsters and paying to have it removed. EPA requires its construction contractor, Clark Construction Group, to salvage and to recycle or reuse the following materials:

- Land clearing debris
- Concrete, masonry, and other inert fill materials
- Metals
- Untreated wood
- Gypsum wallboard scrap
- Reusable lumber, fixtures, and building supplies
- Cardboard
- Paper
- Plastic buckets
- Beverage containers
- Other mixed construction and demolition waste

EPA also requires that materials be sorted and collected according to procedures specified in the construction contract. Glass, for example, must be sorted by color or type. Gypsum wallboard can be deposited at an offsite gypsum reclamation or recycling facility, or ground up and used as an onsite soil amendment (within established limits based on the soil composition at the site).

Clark Construction Group was also required to submit a Construction Waste Management Plan before starting construction. The plan outlined how the contractor proposes to collect, segregate, and dispose of all construction waste and debris produced during construction, subject to EPA approval. It also lists the local facilities that will accept each construction material for reuse or recycling.

While limited recycling already occurs at many construction sites, the construction contract details several nonstandard industry practices. Before requiring the collection of construction materials, EPA worked with a local regional construction waste task force to identify all of the construction materials being recovered in the Research Triangle Park area, even those on a limited scale.[7] EPA expects that the growing local recycling market will support the contractor in meeting the recycling requirements.

[7] The Triangle J Council of Governments in RTP, funded by an EPA grant, developed an off-the-shelf "WasteSpec" that is now available for use by any designer or builder. The EPA design team participated in the development of the specification and incorporated many of its measures into the new RTP facility. (For additional information, see the resource list in Appendix D.)

EPA believes that the contractor will discover that it is less expensive and perhaps even profitable to recycle. EPA's intention is to demonstrate these economic incentives to the contractor with the hope that the practices will be continued on other jobs and by other contractors, which will have positive and enduring effects on the local economy.

Mandatory Environmental Training

Construction safety is a concern at every construction site. To promote worker safety, many construction firms require workers to participate in a safety awareness program prior to beginning work at a new construction site. The program typically includes a discussion of worker safety and a video that addresses any site-specific or project-specific safety concerns.

As part of the training for EPA's laboratory facility, EPA expanded the scope of the training to include environmental concerns. For a significant portion of the worker orientation, including about half of the 12-minute training video, environmental issues are addressed, including:

- Separating construction waste for reuse or recycling.
- Maximizing indoor air quality.
- Protecting site ecology.

Every worker on the project must complete the training. Upon completion of the training, workers are issued a sticker stating, "I've been trained." The sticker must be displayed on each worker's hard hat to indicate that they have completed the training and to remind workers that both safety and environmental protection are always a concern.

Additional Contractor Requirements

The EPA design team is also requiring the contractor to adopt other environmentally preferable practices. For example, in an attempt to minimize truck traffic and the atmospheric pollutants that accompany it, and to preserve landfill space, the contractor is not allowed to dispose of surplus excavated materials off site. The contract also encourages the contractor to use crushed excavated rock in structural fills on site to avoid the need to transport the materials to the site. EPA is also encouraging the contractor to mix all concrete on site to minimize the need to transport it long distances. Mixing concrete on site will eliminate an estimated 75,000 truck miles during construction, conserve approximately 15,000 gallons of fuel, and eliminate the associated emissions.

The construction contract prohibits the contractor from using slash and burn techniques to clear the construction site. On a typical construction site, the contractor will sell the trees for timber and burn the remaining ground cover. EPA is requiring that any remaining wood be ground up and used as mulch on the site after construction is completed with any surplus being transported to a local wood recycling facility.

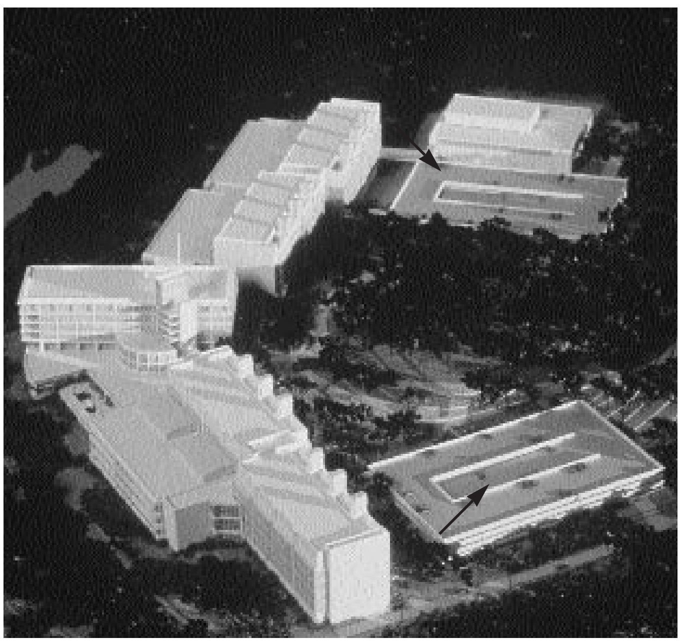
EPA is also requiring the construction contractors to reuse construction materials when possible. For example, EPA is expanding the existing onsite central utility plant and is requiring the contractor to remove and preserve the existing precast concrete panels from one end of the building so that they can be reused on the new addition. This reduces costs for disposal and new material acquisition, saves landfill space, and promotes source reduction.

Protecting the Natural Environment

Although many of the environmental features of the new EPA facility will not be visible to the casual observer, employees and visitors will immediately recognize the results of EPA decisions to protect the natural beauty of the site. When balancing function, the environment, and cost, EPA often discovered that protecting the site's natural environment saved money and promoted other environmentally desirable goals.

Parking

One of the most challenging environmental design decisions made by EPA's design team affected the amount of parking at the new office complex. In a conscious effort to minimize the environmental impacts of large surface parking lots, EPA limited the number of available parking spaces. In so doing, EPA reduced the amount of land that had to be cleared and the number of trees that needed to be removed and reduced future automobile emissions by promoting carpooling and the use of public transportation.



▲ *An aerial view of the facility with arrows indicating the parking decks (model)*

The new office complex will have about 1,800 spaces for approximately 2,200 employees. After excluding designated handicapped and visitor spaces, there will be roughly two parking spaces for every three employees. While this ratio is not unusual for most urban areas, it is unusual in the RTP region because land is abundant and relatively inexpensive. Most nearby facilities—including the NIEHS facility, which is on the same 500-acre federal site as the new EPA complex—provide large surface parking lots with one parking space per employee.

EPA is promoting public transportation as an environmentally preferable option. It is negotiating with the local public bus service to extend a bus route to the EPA campus following building occupancy. The proposed route will also pass the existing NIEHS facility, and EPA hopes the new route will encourage additional federal employees to use public transportation.

In an attempt to further reduce the environmental impacts associated with parking, EPA decided to construct two three-level parking decks and two small surface parking areas, rather than constructing 16 acres of surface parking, which would have required clearing almost 20 acres of trees. Parking decks have several environmental benefits, including:

- Less land needs to be cleared for the same number of parking spaces, which allows more trees to be preserved and protects the natural beauty of the site.

- Large surface parking lots require extensive storm water management procedures that disrupt the natural water cycle, including the resupply of underground water tables.

The remaining surface lots are small enough to employ natural biofiltration techniques to manage storm water runoff. This reduces the need for curbs, gutters, and pipes, which saves additional money and reduces material usage.

▲ An aerial perspective of the entire federal campus before the access roads were reduced to two lanes. EPA's facility is at the top right of the photo. The National Computer Center is at the top left and NIEHS's facility is at the bottom.

Although HOK estimated that parking decks at the EPA facility would cost one-and-a-half times as much as surface parking, EPA determined that the environmental and aesthetic benefits were worth the additional cost. Due to their higher cost, the parking decks were a constant target during cost-cutting exercises. Rather than abandoning the environmental benefits of parking decks, however, EPA project officials implemented other cost-saving design changes to offset their additional cost. For example, EPA and the designers downgraded some of the building's finish materials to less costly but equally durable products. They also removed over 200 interior office suite doors, which saved money and reduced the quantity of construction materials required. Many other trade-offs were made to cover the cost of important environmental measures including the highly energy-efficient building systems and the parking decks.

Tree Survey

The site of the new EPA building is abandoned family farmland that was overgrown with second-growth forest long before it was sold to the government in 1960. It also includes several groves of old-growth oak trees, including a 100-year old oak with a trunk over 11 feet in circumference. When planning the new facility, EPA elected to preserve as many of the old-growth groves as possible, both because of their natural beauty and because they are relatively rare in the RTP region.

In order to facilitate this goal, EPA commissioned a "Specimen Tree Study" that noted the location, diameter, and approximate age of every tree on the property. This study was used by EPA and HOK when situating the EPA facility on the property and when designating the location for the access roads and utility causeways.

Plant Rescues

As the building plans were finalized, several EPA employees realized that a significant number of indigenous flowers and plants would need to be cleared because they were located where the new EPA facility or connecting roads would be built. While the trees would be removed for lumber, several people were concerned that the flowers and plants would simply be destroyed. They decided to do something about it and initiated the first of several EPA-sponsored, volunteer "plant rescues" to preserve the "inherent and intangible value" of the native flowers and plants.

Prior to the first plant rescue, one member of EPA's design team spent several days talking with EPA and other government lawyers to obtain official permission to conduct the rescue. "Basically, what we were proposing to do," he explained, "was give away government property because the plants were on EPA-owned land." Eventually, EPA entered into an agreement with the North Carolina Botanical Gardens, which had sponsored numerous plant rescues on private land in the Research Triangle Park area, to assist with the EPA plant rescue.

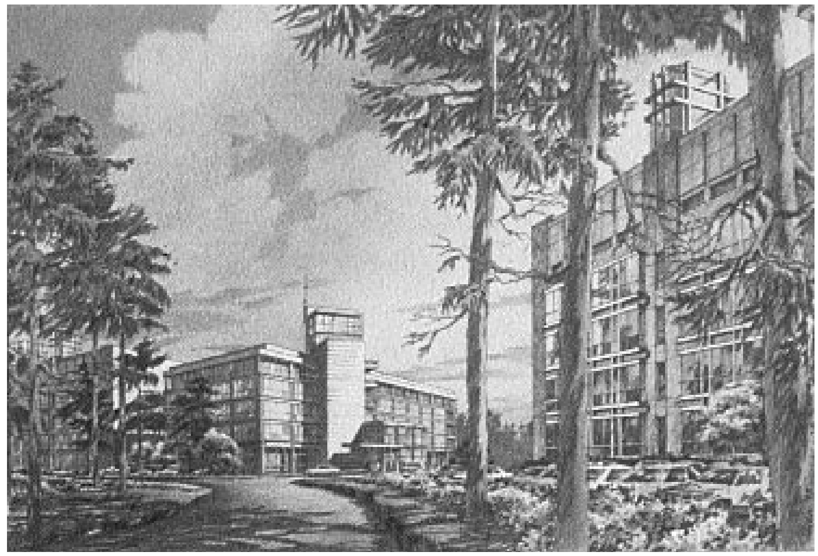
After addressing the legal concerns, EPA invited members of the public to join EPA employees and North Carolina Botanical Gardens volunteers at the site and relocate as many plants as possible to prevent them from being destroyed during construction of the new facility. Approximately 150 volunteers over four Saturdays "saved" over 3,000 plants from a variety of native species, including Christmas ferns, dogwood, downey arrowood, winged elm, green and gold, and wild azaleas. Individual plants were excavated and relocated on the EPA property, the nearby NIEHS site, or to the homes of volunteers

.

Natural Landscaping

EPA also ensured that the landscaping surrounding the laboratory facility minimizes the resources and costs required to maintain it. The landscaping emphasizes indigenous, low-maintenance plants that require little fertilization, pesticide use, or irrigation. Fifteen acres of native grasses and wild flowers will be planted along the roadways to minimize the need to mow the grass. Grass is typically cut 21 times a season. EPA estimates, that by minimizing that need, it will prevent at least 800 pounds of carbon dioxide from being emitted by the lawnmowers each year.

The landscaping, according to the EPA project team, is also designed to be "naturally manicured," which means that there will not be any effort to maintain a "neat, golf course" appearance. Dead trees that do not present a hazard to human health or safety, for example, will remain on the grounds to serve as natural wildlife habitats. This will reduce the need for artificial fertilizers, reduce maintenance, and save money.



▲ *A view of the RTP facility's front entrance*

In addition, EPA plans to formally manage the site as a wildlife habitat when the facility is occupied. It has already joined in a partnership with NIEHS, which shares the 500-acre federal site with EPA, to promote environmental responsibility in grounds management.

Lessons Learned

The size and scope of the RTP laboratory construction project provided many valuable lessons about the environmental attributes of numerous materials, products, and processes. A few of the lessons are specific to the EPA project and, therefore, are not applicable everywhere. There are, however, many lessons that would be relevant to any attempt to incorporate environmentally preferable purchasing into building design and construction.

Commit to an Environmental Goal

With most design and construction projects, function and cost are the primary, and sometimes the only, concerns. As a result, unless there is a strong environmental commitment at the executive and project management levels, most project participants will not consider the project's environmental impacts. It is helpful to assign a senior project manager to the job who is committed to environmental design and who will ensure that everyone involved with the project examines the environmental consequences of each decision in the design process. Assigning environmental oversight responsibilities to one or more people will further ensure that all three factors—function, cost, and environment—are adequately considered and prevent people from examining only the traditional factors of function and cost.

Eternal Vigilance Is Essential

Due to the size and complexity of large building projects, numerous people are involved with the design. Unless each of them fully understands the functional, environmental, and cost concerns driving the project, someone can unintentionally or unnecessarily remove an environmental feature.

> ***"If you aren't watching closely, people forget about the environmental implications of their actions."***
>
> ***EPA Project Manager***

One example often cited by the EPA design team was the attempt to locate an access road through an old-growth oak grove. Although EPA had a "tree survey" prepared to designate which trees should be protected, an engineering firm that was not familiar with all of EPA's design objectives located the road directly through the grove. EPA had assumed that the access road would follow the existing gravel road, which would not significantly threaten any of the oak groves. When the access road was being located, however, the engineers did not consult the tree study and instead placed the road along the shortest distance between the building and the first public road.

Before the path for the road was cleared, EPA discovered the discrepancy and notified the engineers. EPA explained that one of their design goals was to protect the old-growth trees and explained that it was less expensive and less environmentally destructive to relocate the road. Designing the road to follow the existing gravel road, eliminated the costs of removing the trees and grading a new surface, which more than offset the costs of the additional materials needed to construct the slightly longer road. It also prevented the destruction of an existing creek and saved an additional two- to three-acres of trees, including the oak grove containing the 11-foot-circumference oak tree. Relocating the road also, coincidentally, alleviated the traffic congestion that would have resulted under the original plan because the entrance was located farther away from a major intersection. If EPA had not closely scrutinized every phase of the design process, it would not have been able to incorporate as many positive environmental attributes as it did.

Similarly, without HOK's commitment to constantly evaluating the environmental impacts of the design, the environmental quality of the building would have been diminished. For example, when the initial construction bids were significantly higher than EPA anticipated, EPA focused on the recycled-content requirements as a probable cause and was prepared to reduce those requirements in an attempt to reduce costs. (Contractors were not required to itemize their bids, which left EPA without a mechanism to adequately determine the reasons for the higher costs.) HOK, however, supplied EPA with information documenting the availability of competitively priced recycled-content products, suggesting that the cost overruns were due to factors other than the recycled-content requirements. As a result, EPA preserved the requirements, which will improve the overall environmental performance of the building.

To be truly effective, environmental vigilance must come from all parties involved with the design, design review, and construction of the facility.

Be Persistent: Assign an "Environmental Advocate"

Environmentally preferable building design is still a relatively new approach for many segments of the building design and construction community. EPA discovered that it was helpful to assign "environmental advocates" because frequently people deny that there are environmentally preferable ways of doing something because they have never taken the time to investigate them. EPA's environmental advocates learned that persistence pays off. Asking questions and investigating alternatives allowed EPA to incorporate many environmental considerations that might not otherwise have been included.

While design teams typically have many different types of specialists—architects, interior designers, mechanical, civil, and electrical engineers, cost consultants, and others—it is rare to find a design team with a designated environmental advocate. Typically, designs are reviewed throughout the design process by the design firm, the customer, and, on large projects, by an outside reviewer. In the case of EPA's new RTP facility, the review process also included the environmental advocates who had the specific responsibility to ask, "Is it environmentally sound?" This environmental review created a dynamic atmosphere in which traditional concepts were challenged and improved the overall environmental quality of the final design.

Continual Reevaluations Are Important

It is very important to continually reevaluate the environmental preferability of each design decision in relation to the overall environmental preferability of the project. Often times a change to one portion of the design can adversely affect or provide new opportunities to improve other parts of the design. Many such challenges were presented during the design of the EPA facility and are discussed in the case study.

For example, increasing the amount of natural lighting by increasing the number of windows is an important environmental consideration, but it also affects the overall efficiency of the ventilation system. The environmental preferability of the final design, therefore, is contingent not only on the number of environmental attributes included in the design, but on how they interact with each other. Making a "green" decision early in the process does not guarantee the same result later because other factors may have changed. The design process, therefore, should include continual reevaluations of earlier environmental design decisions.

> ***"In the future, I would require a written environmental design analysis at every step—initial conceptualization through final design. That would help focus the entire team—architects, engineers, and reviewers—on the environmental impacts of their decisions at every step of the process."***
>
> *EPA Project Manager*

Value Engineering Can Improve Environmental Performance

As described in this case study, the VE process can improve the environmental performance of a design. Traditionally, the VE process only examines two factors—cost and function. EPA successfully incorporated a third factor—environmental impact—into the VE process, which resulted in significant cost savings and significant improvements in the facility's environmental performance without compromising function. When the group conducting the VE evaluation is aware of the environmental goals and when the project's environmental advocates actively participate in the VE process, VE can enhance both the financial and environmental efficiencies of a project.

Look at the Long Term

The true costs and benefits of many design features are not immediately obvious, unless they are assessed from a long-term perspective. Many of the environmental features recommended under the Green Lights program, for example, dramatically increase initial costs. These energy-efficient purchases, however, will pay for themselves over a period of 7 to 12 years. Given the 50-to 150-year life of a building, the higher initial cost will be worth it from an economic and environmental perspective.

Other investment costs, such as those for waste minimization or recycled-content building materials, are harder to quantify. Their benefits tend not to be realized in terms of dollar "payback" over a number of years, but rather in terms of improvements to society or the sustainability of the planet. "In other words," according to the EPA Project Manager, "they are just the right thing to do." In these cases, it might be necessary to make trade-offs, sometimes difficult ones, to pay for some positive environmental attributes.

Modeling Design Features Is Helpful

EPA and HOK made extensive use of models to identify how selected features or segments of the building would affect indoor air quality or other environmental objectives. While extensive modeling increases design costs, these information costs quickly pay for themselves because they allow the most efficient design to be selected. Two examples in which modeling was beneficial were in determining the height of the exhaust stacks for the fume hoods on each of the laboratory buildings and in selecting the most appropriate design for the atriums that connect the laboratory and office buildings.

Environmental Attribute Information Is Available

EPA and HOK found that there is a lot of information available to help determine the environmental preferability of various building designs, materials, products, and processes. By encouraging all design and construction contractors to seek out the available information and to ask manufacturers and suppliers to provide it, EPA had access to the best available information on the subject. As more customers begin asking for environmental attribute information, additional manufacturers will begin providing it and designing products that maximize each positive attribute, while minimizing the negative ones.

Appendix A

Definition of Low VOC Content Levels As Defined in the RTP Construction Contract

Materials or Product	VOC Content Level
Form Release Agents	350 g/L
Plastic Laminate Adhesive	20 g/L
Casework and Millwork Adhesives	20 g/L
Transparent Wood Finish Systems	350 g/L
Cast Resin Countertop Silicone Sealant	20 g/L
Garage Deck Sealer	600 g/L
Water Based Joint Sealants	50 g/L
Non-water Based Joint Sealants	350 g/L
Portland Cement Plaster	20 g/L
Gypsum Drywall Joint Compound	20 g/L
Terrazzo Sealer	250 g/L
Acoustic Panel Ceiling Finish	50 g/L
Resilient Tile Flooring Adhesive	100 g/L
Vinyl Flooring Adhesives	100 g/L
Carpet Adhesive	50 g/L
Carpet Seam Sealer	50 g/L
Water-based Paint & Polychromatic Finish Coatings	150 g/L
Solvent-based Paint	380 g/L
High Performance Water-based Acrylic Coatings	250 g/L
Pigmented Acrylic Sealers	250 g/L
Catalyzed Epoxy Coatings	250 g/L
High Performance Silicone	250 g/L
Casework Sealant	50 g/L
Liquid Membrane-forming Curing and Sealing Compound	350 g/L

Appendix B

Required Minimum Recycled Content of Materials for the RTP Facility

Material or Product	Recommended Recycle Content
Asphaltic Concrete Paving	25% by weight[3]
Reinforcing Steel in Concrete	60% recycled scrap steel[1]
Reinforcing Bars in Precast Concrete	60% recycled steel[1]
Concrete Unit Masonry	50% recycled content
Reinforcing Bars in Concrete Unit Masonry	60% recycled steel[1]
Framing Steel	30% recycled steel[1]
Fiberglass Batt Insulation	20% recycled glass cullet[2]
Fiberglass Board Insulation	20% recycled glass cullet[2]
Mineral Wool Insulation	75% recycled material (slag)[2]
Mineral Wool Fire Safing Insulation	75% recycled material by weight (slag)[2]
Gypsum Board	10% recycled or synthetic gypsum
Facing Paper of Gypsum Board	100% recycled newsprint including post consumer waste[2]
Mineral Fiber Sound Attenuation Blankets	75% recovered materials by weight (slag)[2]
Steel Studs, Runners, and Channels	60% recycled steel[1]
Acoustic Panel Ceilings	60% recycled material by weight
Ceiling Suspension Systems	60% recycled material[1]
Rubber Floor Tiles	90-100% recycled materials[2]
Hydromulch	100% recovered materials[2]
Structural Fiberboard	80-100% recycled content[2]

[1] 60% represents the average recycled content for the U.S. steel industry. Use of U.S. manufactured steel will meet this requirement.

[2] As per EPA Comprehensive Guideline for Procurement of Products Containing Recovered Materials (60 FR 21370, effective May 1, 1996).

[3] As per North Carolina Department of Transportation (NCDOT) recommendation.

Appendix C

EPA Green Buildings Vision and Policy Statement†

In order to maintain leadership in environmental protection, EPA must lead by example. Through sustainable design and construction of EPA facilities we will model responsible environmental behavior and help create the framework within which the building industry as a whole can shift towards practices which will promote "Green Buildings."

Green Buildings are structures that incorporate the principles of sustainable design—design in which the impacts of a building on the environment will be minimal over the life-time of that building. Green Buildings incorporate principles of energy and resource efficiency, practical applications of waste reduction and pollution prevention, good indoor air quality and natural light to promote occupant health and productivity, and transportation efficiency in design and construction, and during use and reuse.

Agency facilities, both new and existing, should serve as models for a healthy workplace with minimal environmental impacts. To achieve this goal, EPA will utilize both innovative "state of the art" technologies and a holistic approach to design, construction, renovation and use. EPA will work with the private sector to identify opportunities for innovation and to help create markets for both products and design concepts. Important considerations in the design, construction and use of EPA owned and leased facilities include the following:

- Site planning that utilizes resources naturally occurring on the site such as solar and wind energy, natural shading, native plant materials, topography and drainage.
- Location and programs to optimize use of existing infrastructure and transportation options, including the use of alternative work modes such as telecommuting and teleconferencing.
- Use of recycled-content and environmentally preferable construction materials and furnishings, consistent with EPA Procurement Guidelines.
- Minimization of energy and materials waste throughout the building's lifecycle, from design through demolition or reuse.
- Design of the building envelope for energy efficiency.
- Use of materials and design strategies to achieve optimal indoor environmental quality, particularly including light and air, to maximize health and productivity.
- Operation systems and practices which support an integrated waste management system.
- Recycling of building materials at demolition.

† As described in EPA's Environmental Procurement Strategy, August 1995 (EPA200-R-95-001).

- Management of water as a limited resource in site design, building construction and building operations.
- Utilization of solar and other renewable technologies where appropriate.

Evaluation of trade-offs will be an important component of the design of Green Buildings. Where the goals of a Green Building are contradictory (for example increased ventilation vs. increased energy efficiency), the trade-offs will have to be evaluated in a holistic framework to achieve long-term benefits for the environment. Also, the physical considerations must be balanced with other policy objectives such as environmental justice, particularly with regards to site location. We anticipate that there may not always be single answers to recurring building issues, but we will adopt a consistent approach to evaluating all buildings for sustainable design considerations

Appendix D

Green Building Resources

This appendix includes a list of resources for obtaining additional information about the new EPA facilities and about the design, construction, and maintenance of "green" buildings. This is not a comprehensive list of sustainable building resources. Selected products or organizations are included because they are referenced in this document or were mentioned during interviews conducted while researching the case studies. Inclusion of specific products or organizations on this list do not constitute endorsement or recommendation by EPA.

Environmental Building News
28 Birge Street
Brattleboro, VT 05301
Phone: 802 257-7300
Fax: 802 257-7304
Web Site: www.ebuild.com

Publishes information ten times a year on environmentally sustainable design and construction practices, including material selection, siting, indoor air quality, day lighting, and energy-efficiency. The web site includes subscription information, access to back issues, a checklist for environmentally responsible design and construction, and an e-mail discussion list on green buildings.

HOK's Healthy and Sustainable Building Materials Database
Sustainable Design Group
Hellmuth, Obata + Kassabaum, P.C.
Canal House
3223 Grace Street, NW
Washington, DC 20007
Phone: 202 339-8700
Fax: 202 339-8800
Web Site: www.hok.com/sustainabledesign/database/welcome.html

Contains information gathered from over 600 manufacturers on over 1,000 products. The information is based on results of a survey conducted by HOK that asks vendors and manufacturers to provide information on the environmental impacts of their products. It includes information on raw materials (including recycled-pcontent percentages); production processes; packaging and shipping; installation and use; recyclability; indoor air quality impact; and general information on product cost, life expectancy, maintenance requirements, and availability. Each entry includes a "green score" compiled by HOK based on information contained in the database.

The National Park Service's Sustainable Design and Construction Database
Web Site: www.nps.gov/dsc/dsgncnstr/susdb/index.htm

Includes information on approximately 1,300 product listings from over 550 manufacturers; lists over 7,000 construction debris recyclers; and contains an extensive listing of books, periodicals, organizations, and online sources of sustainable design information. The database is not online; it is a downloadable application that operates from within the Windows environment.

Ronald Reagan Building Web Site
Web Site: www.gsa.gov/regions/r11/projects/reagan.htm

Contains additional information about and pictures of the Ronald Reagan building along with a history of the Federal Triangle site.

U.S. EPA's Design for the Environment Program
Pollution Prevention Clearinghouse
401 M Street, SW. (3404)
Washington, DC 20460
Phone: 202 260-1023
Fax: 202 260-0178
Web Site: www.epa.gov/dfe

Helps businesses incorporate environmental considerations into the design and redesign of products, processes, and technical and management systems. DfE initiates voluntary partnerships with industry, universities, research institutions, public interest groups, and other government agencies.

U.S. EPA's Energy Star Buildings Program
U.S. EPA Atmospheric Pollution Prevention Division
401 M Street, SW. (6202J)
Washington, DC 20460
Phone: 202 775-6650
Fax: 202 564-9575
Hotline: 888 STAR-YES (782-7937)
Web Site: www.epa.gov/appdstar/buildings

Encourages energy-efficiency building design and operation, including "Green Lights" upgrades, building tune-ups, load reductions, fan system upgrades, and heating plant and cooling system upgrades. The program has developed several publications and software packages to evaluate energy needs. They are available by contacting EPA or via the program's web site.

U.S. EPA's Environmentally Preferable Purchasing Program
401 M Street, SW. (7409)
Washington, DC 20460
Phone: 202 260-1023
Fax: 202 260-0178
Web Site: www.epa.gov/opptintr/epp

Promotes the consideration of environmental factors in purchasing decisions, along with traditional factors such as product price and performance. The EPP Program provides guidance for federal agencies to facilitate the purchase of goods and services that pose fewer burdens on the environment.

U.S. EPA's Green Lights Program
U.S. EPA Atmospheric Pollution Prevention Division
401 M Street, SW. (6202J)
Washington, DC 20460
Phone: 202 564-9190
Fax: 202 564-9569
Hotlines: 888 STAR-YES
202 564-9659 [fax-back information line]
Web Site: www.epa.gov/greenlights.html

Promotes the use of energy-efficient lighting to prevent the creation of air pollution. The program developed several publications and software packages to analyze lighting needs. They are available by contacting EPA or via the program's web site.

U.S. EPA's Research Triangle Park Facility Web Site
Web Site: www.epa.gov/rtp/new-bldg

Provides visitors with information about the new facility including its environmental features, a tour of the site, construction updates, contact information, and links to several green building sites. It also includes a 47-page "Green Building Bibliography" containing over 200 references that was compiled by one of EPA's design team members.

U.S. Green Building Council
90 New Montgomery Street, Suite 1001
San Francisco, CA 94105
Phone: 415 543-3001
Fax: 415 957-5890
Web Site: www.usgbc.org/programs/programs.html

Promotes the understanding, development, and implementation of "green building" policies, programs, technologies, standards, and design practices. The Green Building Council published the *Sustainable Building Technical Manual* that identifies the environmental issues that should be considered throughout the entire life of a building. It also published a draft of the Leed Green Building Rating System, which establishes an environmental rating for new and existing commercial office buildings based on selected environmental criteria.

WasteSpec
Triangle J Council of Governments
P.O. Box 12276
Research Triangle Park, NC 27709
Phone: 919 558-9343
Fax: 919 549-9390
Web Site: www.tjcog.dst.nc.us/TJCOG/solidwst.htm

Provides architects and engineers with specifications for and information about construction and demolition waste reduction, reuse, and recycling. The 114-page book includes model specifications for each of the 16 divisions of the Construction Specification Institute (CSI) system of specifications, cost information, a sample waste management plan, a checklist of 135 demolition materials, and a list of resources for additional information. It also comes with a diskette containing model specifications that can be "cut and pasted" into existing specifications.