

DOCUMENT RESUME

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INSTITUTION SHW Group, Inc., Dallas, TX.

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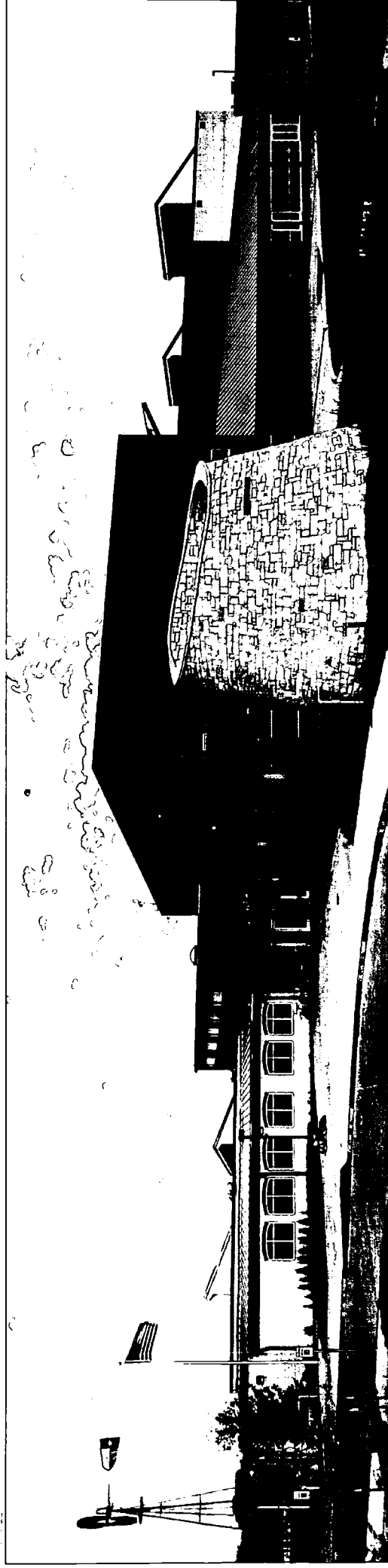
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ABSTRACT

This document describes the sustainable features of the Roy Lee Walker Elementary School (Texas), a prototype "Eco Education" school that blends the physical environment with the student learning process while protecting the site. The document also presents the process of integrating sustainability criteria in all phases of the school's life cycle. The sustainable design features highlighted include the use of wind and solar energy to reduce climate control costs, a rainwater harvesting design to reduce water costs, a natural daylighting design that reduces the need for fluorescent light during the day, and classroom corridor technology that utilizes thousands of square feet of hallway space for learning activities. A floor plan and project timeline are included along with a paper that documents the school's sustainable features, which was presented on May 16, 2000, at the Twelfth Symposium on Improving Building Systems in Hot and Humid Climates. (GR)

ROY LEE WALKER ELEMENTARY
HIGH PERFORMANCE SUSTAINABLE SCHOOL DESIGN
MCKINNEY, TEXAS

ED 455 674



EF 005 975

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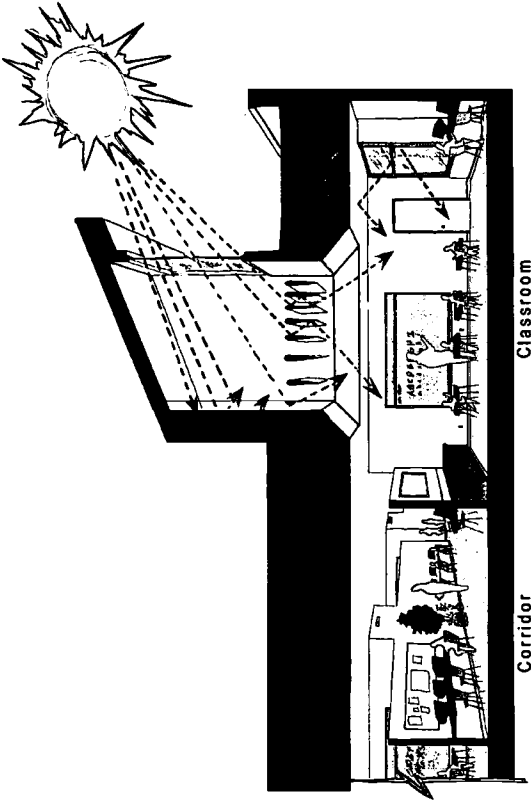
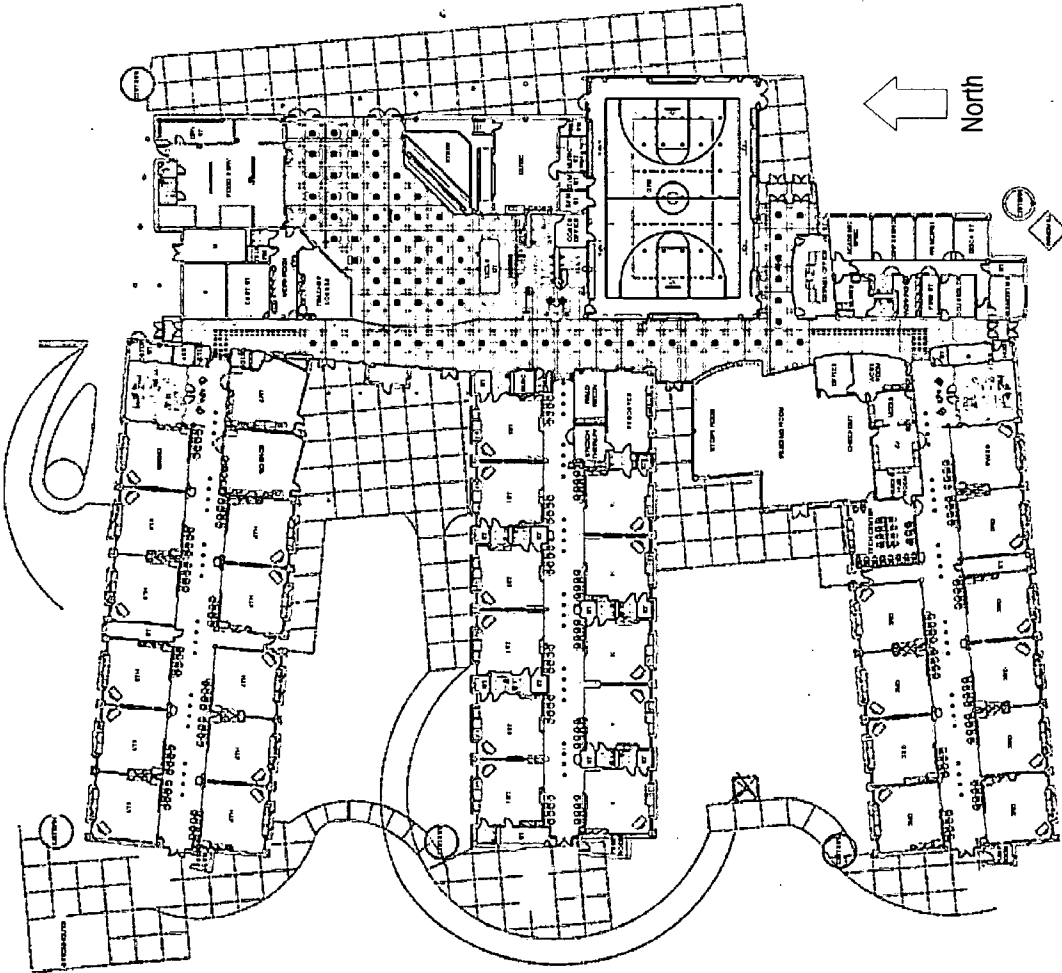
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Architect: SHW Group, Inc.
Consultant: Innovative Design
Contractor: Pogue, Inc.
Capacity: 680 students
Grades: K-5
Area: 68,800 sq. ft.
Site Size: 8.5 acres
Cost: \$9,290,000
Completion Date: July 2000

Building Features:
 Daylighting
 Rainwater Harvesting
 Wind Energy
 Solar Energy
 Water Habitat
 Sundials
 Eco-Education
 Weather Station
 Natural Vegetation
 Community Recycling

Roy Lee Walker "Sustainable" Elementary School
 McKinney Independent School District
 McKinney, Texas



Daylighting

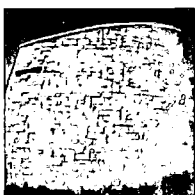
Daylighting is this school's key ingredient. These vertical daylight monitors scoop the natural sunlight, providing all the light needed in the learning environment during the day. The sunlight is drawn into the light monitor and bounced off a series of baffles to provide soft, evenly distributed daylight throughout the learning spaces.



BONUS: By reducing (and in some cases eliminating) the need for florescent light during the day, McKinney ISD is able to realize substantial reductions on their utility bills. Also, because sunlight gives off less passive heat than florescent light, money is not wasted cooling the passive heat gain normally associated with the artificial light.

Rainwater Harvesting

Six cisterns surrounding the school provide storage for up to 68,000 gallons of collected rainwater. The school is designed to collect all rainwater that hits its roof. This rainwater is used to irrigate the landscaping and drastically reduces monthly water bills.



Each cistern has a dedicated filtration system to filter the debris washed from the roof.

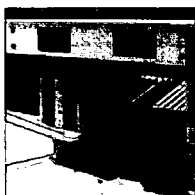
Main Cistern

This cistern, the focal point of the school's aesthetic appeal, has been finished with Austin stone quarried locally in Texas. An overflow feature has been incorporated that converts the front of the cistern into a waterfall should the cistern reach capacity.



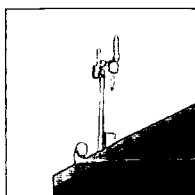
Wind Energy

A windmill harnesses the natural and cost-free energy of the wind to circulate the harvested rainwater through the school's sprinkler system.



Solar Energy

A series of solar panels supplies the majority of the school's hot water needs.



Weather Station

A state-of-the-art weather station uses technology such as sound waves, solar radiation converters, and calibrated barometric pressure sensors to send information to the system's monitoring box located in the main corridor. Other building information, such as the current temperature of the solar powered hot water, is also available at this monitoring box.

Roy Lee Walker Elementary
McKinney Independent School District

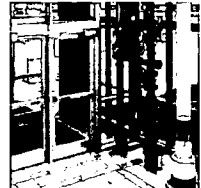
Theme

This main hallway, located outside the dining space, features an arched ceiling with colored tiles to celebrate the school's rainbow theme. The rainbow theme, carried throughout the school, is symbolic of the school's commitment to make everlasting changes for the good of the environment today and tomorrow.



Teaching Tools

Since this school building is intended to become part of the educational program, every effort was made in the design to provide learning opportunities through the building's various elements. For example, just inside the main entrance, the fire sprinkler controls have been left exposed and painted bright red. Normally, the sprinkler heads are the system's only visible elements. In this case, however, the entire sprinkler system can be seen as the piping leads from the controls to the rest of the building.



Also located in this space is a giant gauge that displays how many gallons of rainwater are currently stored in the cisterns.



Sundials

There are two sundials at Walker Elementary. These sundials help students learn how to read time without a clock and identify winter and summer solstices, the shortest and longest days of the year. And, since the sundials do not take daylight savings into account, teachers can demonstrate the earth's relation to the sun as it changes from season to season.



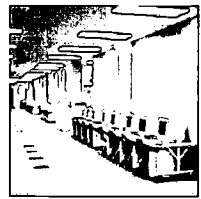
Water Habitat

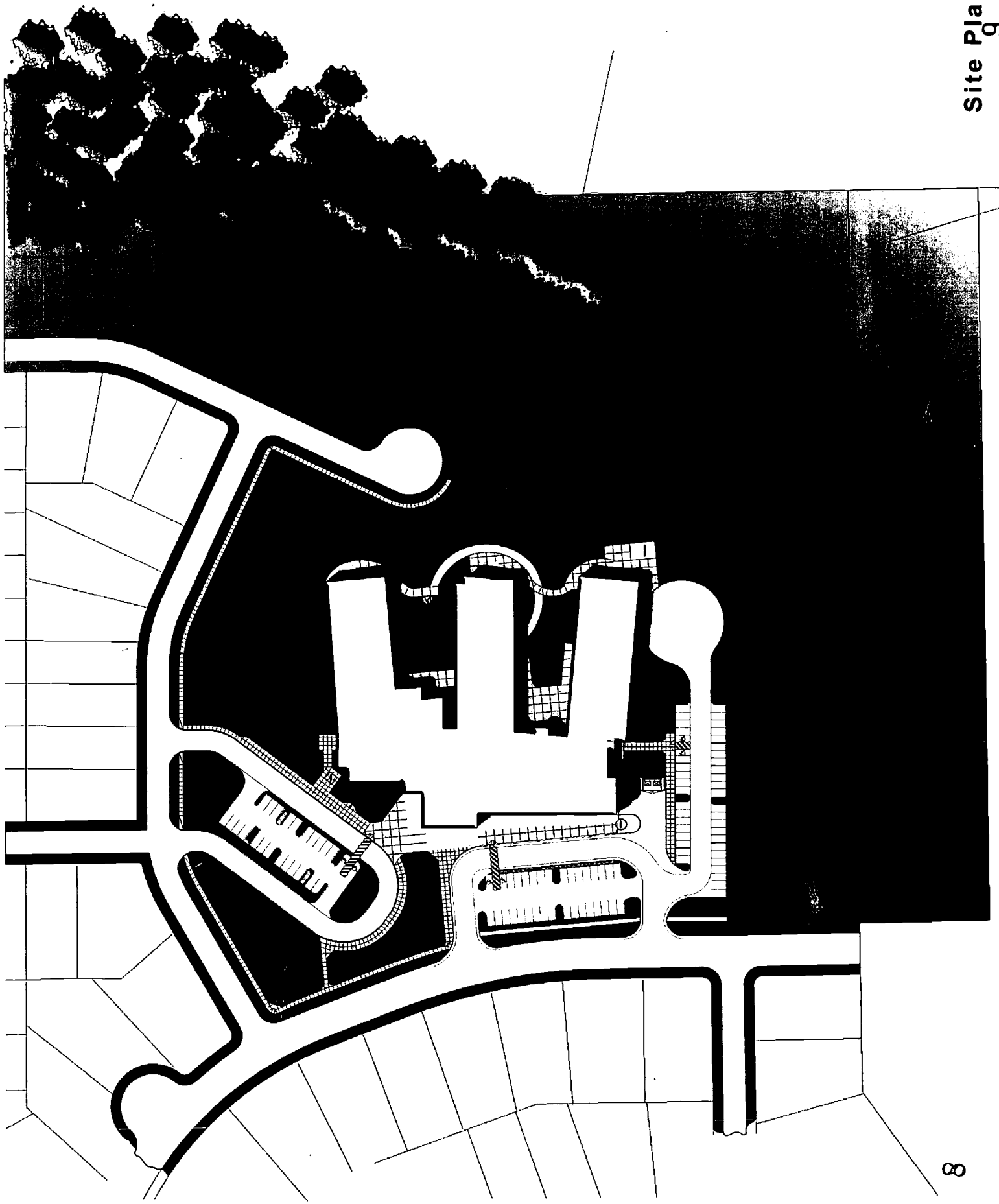
A water habitat developed with natural vegetation provides teachers with a unique teaching tool and allows students to experience their surrounding environment in an educational setting. An old-style hand pump offers students the opportunity to take water from the pond and use it for botany experiments.

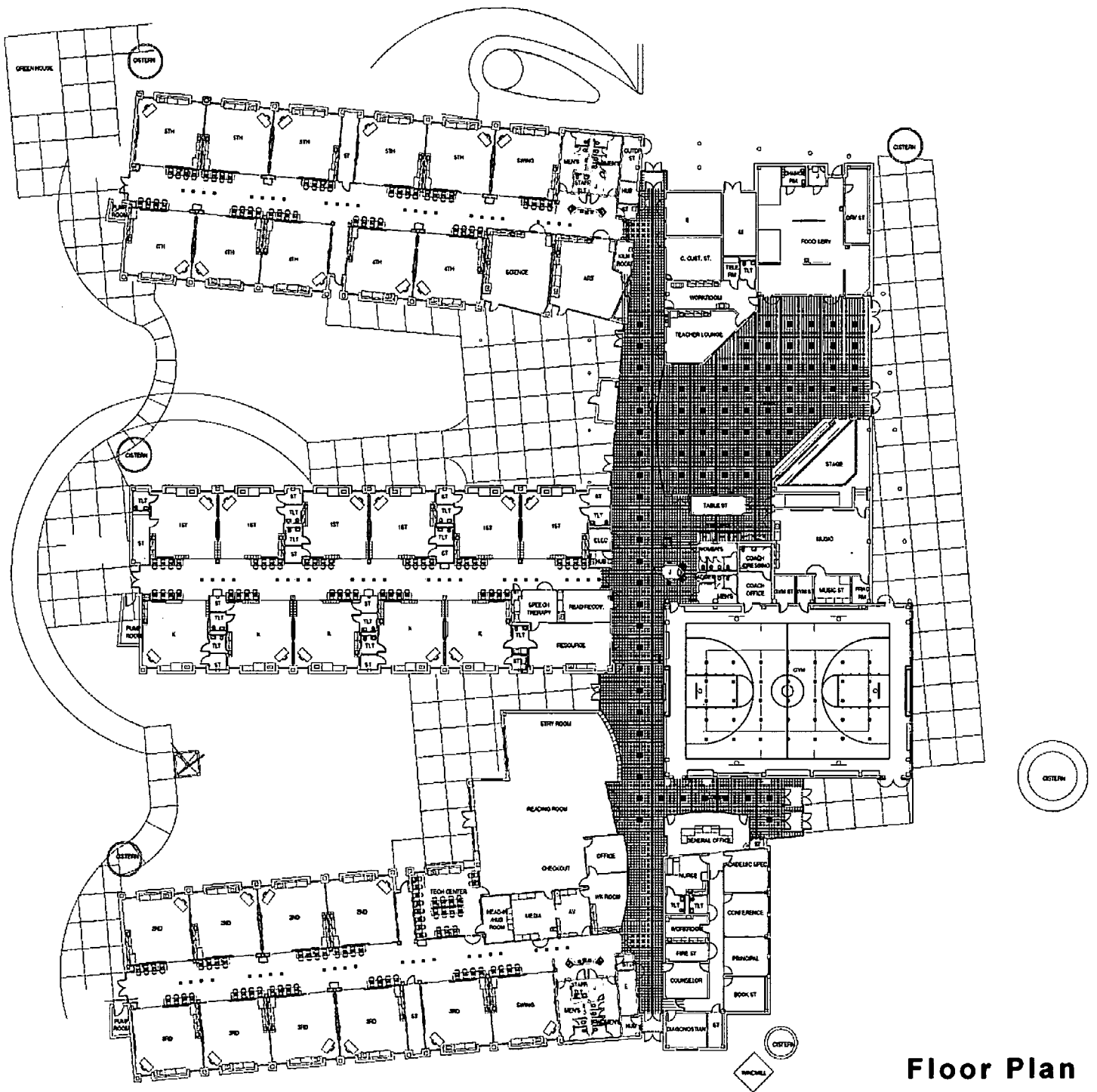


Classroom Corridor Technology

The innovative design of the classroom wings eliminates the waste of thousands of square feet normally dedicated to hallway space. Instead, the corridors have been widened to accommodate additional teaching space and computer technology. Rather than isolate four computers in each classroom, these computers have been grouped together in the hallways, providing every four classrooms with their own computer lab.

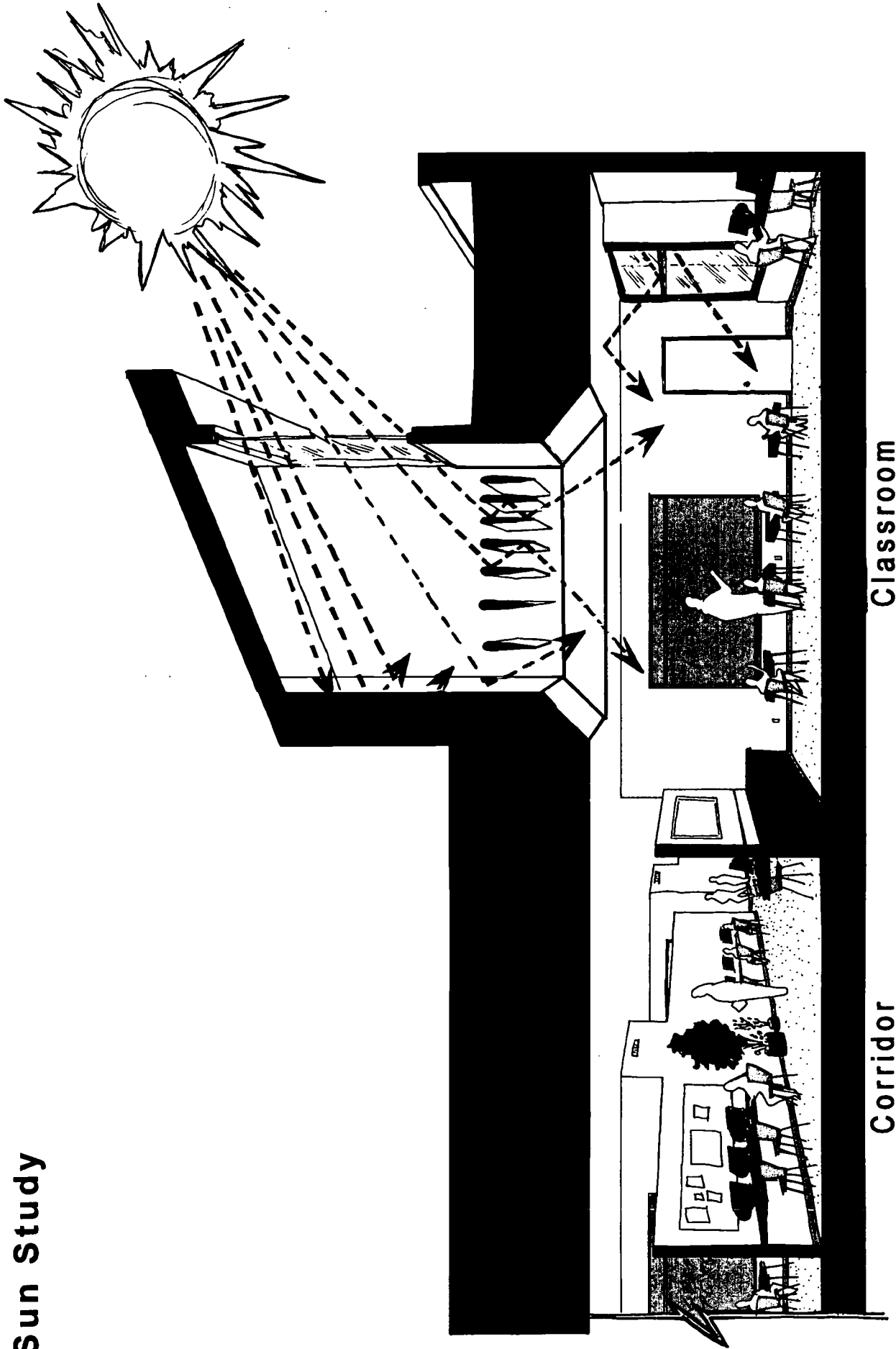






Floor Plan

Sun Study



Project Description

ECOLOGY, n. the branch of biology dealing with the interrelations between living organisms and their environment.

“Through advanced technological methods, an ecosystem has been structured for students at Walker Elementary which allows students to experience first hand their interdependence with nature.”

-- Deb Beasley, Principal
Roy Lee Walker Elementary

Roy Lee Walker “Sustainable” Elementary School represents a turning point in the educational process – for the first time blending the building’s physical environment with the student learning process. Walker Elementary not only houses the educational process within its walls, but its unique design affords it the opportunity to actually contribute to student learning.

This school is unlike anything I’ve seen in my 30 years as a school architect,” said Gary Keep, Chief Executive Officer of SHW Group Architects. “It’s an amazing concept and yet so simple. It just makes sense.”

Touted as the most comprehensive sustainable school in America, if not the world, Walker Elementary includes such elements as daylighting, rainwater harvesting, solar energy, wind energy, sundials, a weather station, a water habitat, natural landscaping, community recycling, sustainable building materials, and the implementation of thorough recycling during construction.

“Our goal was to create the most energy efficient, cost-effective school facility in Texas. For the first time, a school’s physical environment contributed and blended with the student learning process.” CEO

Walker Elementary was developed as a prototype for the district’s next 12 elementary schools scheduled for construction during this first decade of the new millennium. The district has already begun construction on the next two sustainable elementary schools.

The school’s character is defined by the large windmill to the left of the main entry and by the stone cistern to the entry’s right. The windmill is operable and provides the energy to circulate collected rainwater from the cisterns through the school’s irrigation system. The stone cistern serves as the main collection tank supported by five other cisterns around the building. These cisterns collectively store up to 68,000 gallons of

Project Description

rainwater. By using rainwater to feed the Eco-pond and water the landscaping, school officials have substantially reduced city water usage and associated costs.

Immediately inside the main entry are two elements that can be used as teaching tools. First, there is a tall, clear glass tube that serves as a rainwater gauge. This gauge tells how many gallons of rainwater are currently stored in the school's cisterns. The other element is the controls for the building's fire sprinkler system. Typically, the sprinkler pipes are hidden behind walls. In this case, the sprinkler system controls and water pipes have been left exposed to demonstrate how a building's fire sprinkler system works. It has also been painted bright red and is treated as a decorative element in the school's design.

Continuing, the main entry opens into a brightly colored corridor decorated with the colors of the rainbow – a consistent theme throughout the school. The rainbow was chosen as the school's theme to represent the project's efforts to incorporate and protect the natural environment. The main office is located on this corridor and is the first area to demonstrate the use of natural materials such as walls finished with combinations of corkboard and galvanized wall panels. These materials give off zero VOC's and take very little energy to produce, in contrast to many other materials such as vinyl panels and concrete masonry.

The end of this short entry corridor connects to the school's main corridor that runs the length of the building from north to south. Decorated with the same bright, primary colors, this space uses virtually no artificial light as daylight monitors and windows provide plenty of natural light. This corridor leads to the three main classroom wings stretching west, as well as to the library media center and school cafeteria. The cafeteria includes a raised platform stage with the music room located immediately behind it. There are three large daylight monitors in the cafeteria. These monitors "scoop" natural daylight in and, thanks to a series of baffles, evenly distributes the light throughout the space.

One of Walker's truly unique elements is the use of space in the classroom wings. Rather than effectively waste thousands of square feet on hallways, the design team decided to widen the classroom hallways and incorporate this space into the learning environment. Classrooms are open to these corridors and teachers can use the space

Project Description

for group activities. The soft and durable, recyclable carpet allows students to work comfortably on the floor. Additionally, classroom computers have been located in these corridors to provide a unique technology solution. Rather than isolate four computers in each classroom, locating them instead in the corridor provides full computer labs in each classroom wing. This format facilitates the district's team teaching philosophy.

Another key sustainability design element is the inclusion of daylight monitors in every classroom. This, along with the other monitors and windows throughout the building, significantly reduces the amount of electricity used during the day, thus reducing the utility bill as well. The classrooms are equipped with light level sensors that maintain a constant level of light in the learning space, whether it be sunlight, florescent, or a combination of both. On a cloudy day the sensors will kick on the supplemental fluorescents to maintain the constant lighting levels. This feature is instrumental in reducing utility costs.

Descriptions of the key sustainability components at Walker Elementary are listed on the following pages:

Wind Energy

A windmill harnesses the natural and cost-free energy of the wind to circulate the harvested rainwater through the school's irrigation system. This system reduces the building's operating costs by taking advantage of natural, renewable energy source.

Solar Energy

A series of solar panels supplies the majority of the school's hot water needs, thus reducing the for electrical power to perform the same job.

Rainwater Harvesting

Six cisterns surrounding the school provide storage for up to 68,000 gallons of collected rainwater which would normally go to waste. The school is designed to collect all rainwater that hits its roof. This rainwater is used to irrigate the landscaping which drastically reduces monthly water bills. This is a huge conservation element in a climate that can go up to several months without a drop of rain, as it did from July through September, 2000.

Project Description

Each cistern also has a dedicated filtration system to filter the debris that washes from the roof.

Daylighting

Daylighting is this school's key ingredient. These vertical daylight monitors scoop the natural sunlight, providing all the light needed in the learning environment during the day. The sunlight is drawn into the light monitor and bounced off a series of baffles to provide soft, evenly distributed daylight throughout the learning spaces.

BONUS: By reducing (and in some cases eliminating) the need for florescent light during the day, McKinney ISD is able to realize a reduction on their utility bills.

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There are two sundials at Walker Elementary. These sundials help students learn how to read time without a clock and identify winter and summer solstices, the shortest and longest days of the year. And, since the sundials do not take daylight savings into account, teachers can demonstrate the earth's relation to the sun as it changes from season to season.

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Water Habitat

A water habitat developed with native vegetation provides teachers with a unique teaching tool and allows students to experience their surrounding environment in an educational setting. An old-style hand pump offers students the opportunity to take water from the pond and use it for botany experiments.

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Project Description

widened to accommodate additional teaching space and computer technology. Rather than isolate four computers in each classroom, these computers have been grouped together in the hallways, providing every four classrooms with their own computer lab.

Main Cistern

This cistern, the focal point of the school's aesthetic appeal, has been finished with Austin stone quarried locally in Texas. An overflow feature has been incorporated that converts the front of the cistern into a waterfall should the cisterns exceed capacity.

Teaching Tools

Since this school building is intended to become part of the educational program, every effort was made in the design to provide learning opportunities through the building's various elements. For example, teachers can create math lessons that calculate the amount of rainwater collected in a one-hour period if it rains $\frac{1}{2}$ inch per hour. The only other variable needed is the square footage of the roof.

January 1998

McKinney Independent School District's Board of Trustees authorizes Wyndol Fry, Executive Director for Facilities, Construction and Transportation, to chase a \$400,000 state grant established to develop a 21st century sustainable school prototype. This grant is offered by the Texas General Services Commission's State Energy Conservation Office.

February 1998

Wyndol Fry and his team write the District's grant proposal and put together a presentation to be made before the Texas State Energy Conservation Office's Grant Selection Committee.

March 1998

Wyndol Fry, the superintendent, and two school board members deliver a presentation before the Grant Selection Committee where they convey the District's vision to build a sustainable elementary school that would serve as the model for McKinney's next 12 elementary schools.

Grant's Requirements – The qualifying school district would already have the bond money available to build the school. Any of the 1,046 school districts in Texas meeting this requirement were eligible to receive the grant. Only two of the possible 1,046 school systems in Texas earned this grant.

April 1998

The State Energy Conservation Office notifies McKinney ISD that the Grant Selection Committee decided unanimously to split the grant amongst two school districts with outstanding grant proposals – McKinney ISD and Austin ISD, the capital of Texas.

McKinney ISD receives \$200,000 from the state to offset additional design costs associated with designing the sustainable school prototype.

May 1998

McKinney ISD employs SHW Group Architects to design this new school prototype and Pogue, Inc. to serve as the project's Construction Manager At-Risk. The District also hires Innovative Design out of North Carolina as a consultant to SHW Group on sustainable initiatives. *Involving the Architect and Contractor this early in the development of the project's new concept was absolutely critical in making this project a successful reality.*

Timeline

May 1998

McKinney ISD brings its staff, SHW Group and Pogue, Inc. to the Texas Sustainable Building Professional Training Seminar where the project team was introduced to the concepts and elements of sustainability.

June 1998

McKinney ISD staff, SHW Group and Pogue, Inc. visit the latest examples of sustainable schools in North Carolina. These schools collectively demonstrated such elements as daylighting, geothermal energy, sustainable building materials, and recycling during construction.

August 1998

McKinney ISD and SHW Group Architects bring together a representation of ALL the project's stakeholders for a week-long design charrette to develop the school's initial schematic drawings. This process involved more than 22 McKinney ISD staff, including administrators, teachers, staff, and students, as well as many community members, the architects, Innovative Design, the contractor and other project consultants such as the landscape architect, MEP and civil engineers, and a representative from the State Energy Conservation Office.

September 1998 through March 1999

The Construction Documentation phase during this period of time involved frequent design review sessions to ensure that the documents accurately reflected the project's sustainable design components. These review sessions were key factors in maintaining a close eye on the costs associated with the sustainable elements. For example, close attention was paid to such things as how much gas it would take a truck to transport materials from the manufacturing point to the school site. Consequently, ACME brick was selected over all the other possibilities because it was manufactured only 30 miles away in Denton, Texas.

February 1999

The project opens for bid and comes in substantially over the allotted budget of \$8.75 million. The Board of Trustees asks the design team to go back and find ways to cut the cost.

March 1999

The Board of Trustees approves Pogue's second bid at \$9.25 million.

April 1999

McKinney ISD's Sustainable Elementary School Project earns recognition from the American Institute of Architects as one of Earth Day's Top 10 Environmentally Responsible Design Solutions in the United States. This project was the ONLY school on the list and competed against such high profile projects as the Duracell Headquarters, Missouri Historical Society Museum, New York Life Building, REI's Seattle Flagship Store, and the Georgia Tech Aquatic Center (Olympic Natatorium).

June 1999

McKinney ISD breaks ground on its new prototype sustainable elementary school with a scheduled completion of June 2000.

June 26, 2000

Date of Substantial Completion.

August 8, 2000

First day of school.

September 2000

Roy Lee Walker Elementary earns the C&A National Sustainability Award.

SUSTAINABLE FEATURES OF MCKINNEY ISD ELEMENTARY SCHOOL

James D. McClure, P.E.
Estes, McClure & Associates, Inc.
Consulting Engineers
3608 West Way
Tyler, Texas 75703

James M. Estes, P.E.
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Gary Keep, AIA
SHW Group, Inc.
Architects
4101 McEwen North
Dallas, Texas 75244

ABSTRACT

Students planning to attend McKinney Independent School District's newest 70,000 square foot elementary school when it opens in the fall of 2000 are in for a special treat.

In addition to standard elementary school curriculum, students will have the unique opportunity to study wind and solar energy, feed their frogs and take care of the school's water habitat, learn in classrooms illuminated by the sun rather than electric light, water their bean plants (which they keep in the school's greenhouse) with harvested rainwater, and check the weather at the campus weather station.

This project was named by the American Institute of Architects to the Earth Day Top 10 List for Environmentally Responsible Design Projects in the nation.

Sustainable design is environmentally sensitive architecture and engineering – the ability to meet today's needs without compromising the resources available to future generations. Environmental conservation is only one of the reasons to consider sustainable design. Studies are showing that the various environmental benefits of sustainable design also benefit our children in the classroom.

Another major element of sustainable design is called "Eco Education", a concept that incorporates the sustainable school into the curriculum so that students can understand its design and how it impacts the environment. It's a tremendous teaching tool for students to learn about environmental conservation.

Harvesting rainwater is a perfect example. By collecting rainwater from the roof of the building and channeling it to one of six on-campus storage tanks, enough water can be collected to flush toilets and water the grounds. Other elements of sustainable design include site planning and landscape management; the use of recycled building materials; solar systems; wind energy; geothermal energy (using the Earth's natural energy to heat and cool the building), energy recovery, and high energy efficiency.

The primary goal of sustainable design is to protect a site's existing environment. As much as possible, we need to understand and maximize the natural conditions of a new project's site and incorporate its features into the overall design. That's what sustainability is all about.

The purpose of this paper is to present the specific sustainable features of the McKinney ISD Elementary School and the process of integrating sustainability criteria in all phases of the school's life cycle.

SUSTAINABILITY – AN INTEGRATED APPROACH

The philosophy of sustainability for the McKinney ISD Elementary School is to integrate and incorporate sound environmental practices and resource management into the master planning, designing, constructing, operating, maintaining, educating, and leading by example phases of the school. Sustainability may be described as meeting the needs of today's children without compromising or sacrificing the ability of future generations to meet their needs. McKinney ISD's Sustainable Elementary School demonstrates an integrated approach to sustainability in schools. Low environmental impact and high energy efficiency are two key factors.

The State of Texas Eight Step Sustainable Building Program for new construction includes the following criteria developed by the State Energy Conservation Office (SECO).

- Siting
- Materials
- Energy
- Water
- Waste
- Indoor Air Quality
- Pest Management
- Building Maintenance

The McKinney ISD project's integrated approach included these criteria and other environmentally sensitive decisions in transportation and construction. A primary goal was for the school

itself to be used as an educational tool for eco-education and science.

McKINNEY ISD's DECISION FOR SUSTAINABILITY

The State Energy Conservations Office (SECO) of Texas issued a request for proposals to provide selected sustainability consulting assistance for a Texas ISD that would construct a school with sustainability as prime criteria. McKinney ISD's proposal team included two school board members, the Superintendent, the Director of Operations, Architect, Engineer and Contractor. McKinney ISD's school board adopted a resolution supporting the proposal and committing to build a sustainable school. McKinney ISD was selected by SECO.

The District's decision to go in this direction was based on several factors, including it's long-term commitment to energy efficiency in schools, prior success in school technology leadership and sustainability, and a strong desire for excellence in schools for the students and community. McKinney ISD has 14 campuses, and about 10,000 students located in a rapid growth area in McKinney, Texas north of Dallas on Highway 75. The District in 1992 renovated a 1930's campus into the ACT Academy (Academic Competitiveness through Technology) campus, which was one of the first school campuses in the nation to have massive application of computers for education. Sustainability was a consideration in this facility via energy efficiency and renovation of a 1930's building as opposed to demolition and new construction.

Other District energy efficiency examples include Energy Efficient School Partnership with the State Energy Conservation Office, SECO's LoanSTAR low interest loan for energy retrofit projects, McKinney ISD funded energy retrofit projects, host for an energy and sustainability workshop, and energy efficiency as a prime design criteria in school construction projects.

During the initial design phase of this project Dr. Jack Cockrill, Superintendent, retired, and Dr. David Anthony was named Superintendent. Dr. Anthony and Wyndol Fry attended design meetings, and McKinney ISD accepted bids for the Sustainable Elementary School, which is scheduled for completion in June 2000. At the time of construction documents release, the school name was Hidden Creek Elementary; however, it is now named Roy Lee Walker Elementary. McKinney ISD also has

decided to resite this elementary school design at two other locations and possibly several other sites.

The Architectural/Engineering design team assembled by McKinney ISD includes the following.

Estes, McClure & Associates, Inc.
Consulting Engineers
Mechanical, Electrical, Plumbing, Energy and Sustainability
James M. Estes, P.E.
James D. McClure, P.E.
David Dupont

SHW Group, Inc.
Architectural, Structural & Sustainability
Gary Keep
Mike Elmore

Glenn Engineers
Civil Engineering

McKinney ISD
Wyndol Fry
Owner's Representative

Paul Pogue, Pogue Construction, was an integral part of the planning and design session. A SECO representative attended some design sessions and provided additional sustainability input and consulting. Robin Bailey, SECO Project Coordinator, coordinated SECO's work during the construction phase. SECO funded daylighting and sustainability consultants' inputs from Innovation Design of North Carolina. The planning and design was an integrated team approach.

SUSTAINABLE FEATURES OF McKINNEY ISD ELEMENTARY SCHOOL

The life cycle stages evaluated (Figure 1) during the planning and design phases began with considering the basic raw materials, transportation distance of materials/equipment, and concluded with considerations of recycling, major future renovations and demolition.

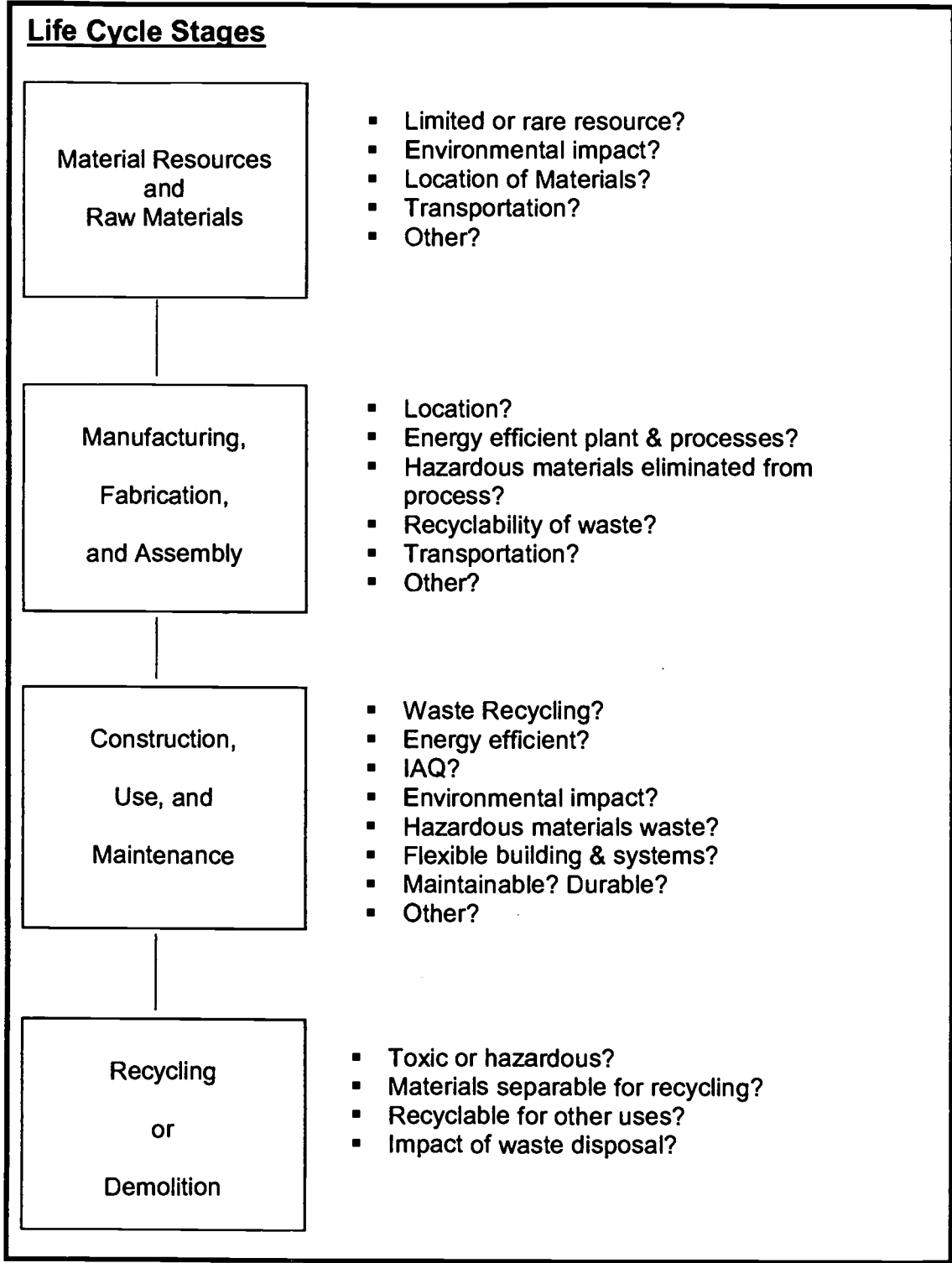


Figure 1. Life Cycle Stages

To the best of our knowledge this will be the first new school constructed in the nation that has sustainability as an integrated criteria in all phases of the building's life cycle.

The McKinney ISD Elementary School has incorporated a significant number of sustainable features as illustrated in Figure 2. Countless features were discussed and considered during the many project meetings and evaluations. Figure 3 lists a few example features evaluated and considered, but not designed and bid.

SUSTAINABLE FEATURES DESIGNED/BID	Incorporated	
	Yes	No
Siting	X	
Daylighting	X	
Geothermal Heat Pumps		X
Energy Mgmt Controls	X	
Solar Energy-Domestic Hot Water	X	
PV Electrical Power		X
Radiant Barrier	X	
Rainwater Collection System	X	
Energy Recovery System	X	
ECO Education Modules	X	
Weather Station	X	
Environmental Material Selected	X	
Recycled Steel	X	
Recyclable Carpet	X	
Rainwater for Toilet Flushing		X
Rainwater for Irrigation	X	
Windmill	X	
Natural Landscaping	X	
Recycling	X	
Transportation	X	
Efficient Lighting	X	
New Sustainable Light Fixture	X	
Lighting Controls	X	
Dimmable Fluorescent Ballasts	X	
Efficient Envelope	X	
Greenhouse	X	

Figure 2. Sustainable Features Designed/Bid

OTHER SUSTAINABLE FEATURES CONSIDERED BUT NOT DESIGNED/BID
Waterless Urinals
Solar Absorption Air-Conditioning System
Zero VOC Paint

Figure 3. Sustainable Features Considered but Not Designed/Bid

Daylighting and Lighting Control

Daylighting incorporates a light monitoring scheme. During bright, sunny days, no artificial lighting should be needed in the classroom. During partially sunny or cloudy conditions, lighting controls will activate dimmable electronic fluorescent ballasts to regulate a uniform lighting level employing T-8 fluorescent lamps in an efficient sustainable troffer.

Air Conditioning System

Geothermal heat pumps were selected as the air conditioning system after reviewing options that included:

- Screw or centrifugal chillers, water-cooled system, four-pipe type.
- Air-cooled packaged screw chillers, central systems.
- Double effect absorption chillers with solar collectors.
- Geothermal heat pump system.
- Air-cooled individual direct expansion (DX) type system.
- Individual packaged rooftop DX units using Trane's two compressor units.
- Standard individual packaged DX rooftop units.

This selection was based on several factors that included, but are not limited to first cost, total school budget, life cycle cost, Owner's preference for individual type systems, sustainability issues, and energy efficiency.

For the past several years, independent testing by Estes, McClure & Associates, Inc. of individual DX air conditioning equipment in three classrooms has identified several individual DX applications for classrooms that control temperature and humidity, provide adequate ventilation, and are extremely energy efficient. Actual classrooms were used for testing. Packaged DX rooftop units (RTU) equipment tested included the following:

- Standard packaged DX unit with Rooftop Systems, Inc.'s (RSI) passive desiccant energy recovery wheel.
- Trane dual compressor DX unit with a 3-ton and a 1.5-ton compressor.
- Lennox DX RTU with condenser reheat.
- York DX RTU with coil modifications.
- Carrier RTU DX/Dehumidification Package

The above-mentioned Trane, Lennox, Carrier and RSI equipment is commercially available. The special York unit was a test only unit. All of the units have controlled temperature and humidity in the test classrooms. The most energy efficient were the

standard RTU with the RSI passive energy recovery wheel and the Trane dual compressor unit. Observed characteristics from the continuous test data show that for the Trane dual compressor unit, the 3-ton compressor came on in the morning for about 0.5 hour, then would shut off and the 1.5-ton compressor would turn on and provide cooling for the remainder of the day. When the outside air temperature was very high (greater than 100°F), the 3-ton compressor operated some during the last hour of occupancy. This dual compressor sequence of more continuous operating time of the 1.5-ton compressor resulted in lower classroom humidity levels than having only a 3-ton compressor air conditioning unit installed. Also, the SEER of the unit increased to about 16 in this mode, which is very energy efficient. This unit resulted in very high energy efficiency, extremely good classroom humidity control, and CO₂ levels below the target values in the ASHRAE standards.

The final selection for the McKinney ISD Elementary School was individual (one per classroom) split system DX air-cooled heat pumps employing the RSI passive desiccant energy recovery wheel, all controlled by a direct digital control (DDC) system. Because of the total project cost, the Owner selected various options including this air conditioning system approach which was \$360,000 less first cost than the geothermal system. The selection of the system was based on the prior independent testing and monitoring of other schools that demonstrated energy efficiency resulting from the inherent flexibility and control of operating with individual units, accurate sizing of equipment, DDC controls, proper zoning, and energy recovery. This approach also complied with the Owner's requirements for operations and maintenance. The configuration of the light monitors for daylighting also prevented adequate space for individual packaged rooftop units.

Photovoltaic (PV) Electric Power

A 5 kW PV electric power system was designed and bid. The system was integrated into the school's electrical power distribution system rather than allocated for one specific function. The PV solar panels were designed as part of the entrance for visibility of this renewable energy source. Because of needed cost reduction, the PV system was deleted after bidding.

Solar Energy System -- Domestic Hot Water

Flat plate active solar energy collectors are provided for domestic hot water. Eight collectors located on the roof will provide hot water for the kitchen. A demonstration solar collector will be

located at ground level as part of the Eco-education.

Eco-Education

The McKinney Elementary School is a teaching tool for incorporating the environment into the education program. Eco-education modules include the following:

- Sun dial
- Visible rainwater collection system
- Active solar energy collectors
- Air conditioning unit cut-away
- Interactive computer module with Eco-modules, building systems instrumentation for display, dynamic graphics, etc.
- Daylighting
- Greenhouses
- Eco-pond
- Campus weather station
- Natural landscaping

SUSTAINABLE PRODUCT SURVEY

Materials, equipment, and product information considering sustainability issues were reviewed by the planning and design team. Information and data were available from manufacturers and publications on a large number of architectural related materials and products (e.g. floor coverings, paints, finishes, etc.). Evaluated resources, relating to the air conditioning, mechanical, plumbing, and electrical systems, focused on energy efficiency and water conservation, and ignored other environmental issues related to the material's life cycle. Estes, McClure & Associates, Inc. conducted a survey of major air conditioning and lighting equipment manufacturers. Figure 4 is an example of one of the survey formats used to evaluate the life cycle stages of air conditioning equipment. Different survey responses were requested for specific air conditioning products from each major manufacturer.

Almost all manufacturers, air conditioning and lighting, responded to the survey. Some surveys were incomplete for various reasons, such as unknown, proprietary, or waiting on legal approval to release. Respondent data is not included in this summary paper. The survey approach and format used is presented because it was instrumental in selecting, developing, and incorporating sustainable features into the McKinney Elementary School that otherwise would not have been included. For example, one of the lighting specific surveys was sent to Lighting Alliance of Carrollton, Texas. Lighting Alliance, working with Lithonia, responded to the Product Information Request. This Product Information Request stimulated a dialog between engineer and the

manufacturer that resulted in the development and manufacturing of a new sustainable product for the McKinney Elementary School. The artificial lighting in the school is primarily from fluorescent fixtures. The manufacturer developed and produced a new T-8 fixture that was specifically designed for the smaller diameter T-8 lamp and low profile electronic ballasts. The resulting fixture has less pounds of material and

higher reflectance than other available standard fluorescent fixtures. The reduction in weight results in less basic raw materials being consumed, and lower transportation related energy use and cost. This new sustainable product, released in December 1999, is scheduled for the McKinney Elementary School. Nine test fixtures were produced in advance and field-tested in an actual classroom.

**PRODUCT INFORMATION REQUEST
for
McKinney ISD Sustainable School**

1. Are hazardous by-products produced?	Yes	No
Explain:		

2. What is the energy required in the process?	BTU/lb. Of Product:

3. Is the process waste generated?	Yes	No
Explain:		

4. Are resources used in the product limited?	Yes	No
Explain:		

5. What basic raw materials are used in the product? (% by weight) wt = _____ lbs.
_____ % _____ % _____ %
_____ % _____ % _____ %
_____ % _____ % _____ %

6. What is the environmental impact of extracting the raw materials?
Explain:

7. Is recycling and reclaiming of waste used at the manufacturing plant?	Yes	No
Explain:		

8. Are any EPA targeted chemicals used in the process (e.g., toluene, lead, mercury, etc.)?	Yes	No
Explain:		

9. What efforts have been made to reduce emissions and the environmental impact?
Explain:

10. Is the manufacturing plant energy efficient?
Explain Steps Taken:

11. Will the end product have any outgasing materials?	Yes	No
Explain:		

12. Is there any formaldehyde, asbestos or mercury in the product?	Yes	No
Explain:		

13. Are any CFC's used in the production process?	Yes	No
Explain:		

14. What is the energy efficiency of the end product?
Explain:

15. What refrigerants are available?
Explain:

16. Does the product have any certification such as Green Seal, etc.?	Yes	No
Explain:		

17. How will the product be shipped from the manufacturing plant to McKinney, Texas?
Explain:

18. Where is the product manufactured and assembled?		
Explain:		
19. Where are major components manufactured (e.g., compressor, etc.)? Identify any components or subcomponents manufactured, assembled, or produced from outside the U.S.A.		
Explain:		
20. Product Warranty?		
Explain:		
21. What oils, etc. are included in the product?		
Explain:		
22. Is this product or components of this product recyclable?	Yes	No
Explain:		
23. What steps have been taken to control IAQ during the use of this product?		
Explain:		
24. Describe features/capabilities for humidity control?		
Explain:		

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Table 4. Information Request Form

RESOURCE/MATERIALS UTILIZATION

The life cycle stages evaluation approach outlined in Figure 1 was used as a guide to evaluate the different components of the building and building systems during the planning and design phase. The following are a few examples of the numerous evaluations.

- Floor coverings
- Structural steel and brick
- Construction waste management
- HVAC systems
- Water

Carpet is required to be 100 percent recyclable. Coordination with carpet manufacturers resulted in specifying that the carpeting shall be recycled at the end of its useful life in an environmentally responsible program run by the carpeting supplier/manufacturer. Re-using and recycling 100 percent of the returned product in new products is required and the supplier/manufacturer shall utilize the full resource potential of the returned material. No carpeting returned for recycling shall be put in a landfill or incinerated. The carpet supplier/manufacturer is required to provide a statement from the United States Environmental

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Protection Agency that states that the products to be provided meet federal guidelines for recycled content.

Structural steel and brick were procured from local area sources to utilize local resources, a key sustainable criterion, in order to reduce transportation (energy and pollution) impact on the environment and transportation cost. The structural steel is from a local manufacturer that recycles steel.

Construction waste management includes, but is not limited to recycling of waste steel, carpet, paper, cardboard, and wood products. Although the waste management company serving the City of McKinney does not currently recycle gypsum drywall products and paint products, they are fully recyclable materials and the suppliers are encouraged in the specifications to set up a recycling program.

Options for air conditioning systems were evaluated on first cost, energy costs, system energy efficiency, Owner's maintenance program, Owner's preference/requirements, and other factors. In addition other resource/materials utilization parameters (Figure 5) were reviewed. For example, the central chiller, boiler, 4-pipe, water-cooled system had more pounds of total weight, consumed water, required chemicals for treatment and the equipment was transported longer distances than the other options illustrated in Figure 5. The geothermal heat pump system, although being the base bid system, had an additional 20 miles of underground

plastic pipe that the other systems did not require.

Water is a resource that received significant consideration in the planning and design phases, especially considering the recent and current drought that includes the McKinney ISD region. A unique rainwater collection and utilization system was formulated, designed and bid. The collected rainwater was designed for irrigation at the campus and for use in flushing plumbing fixtures. In addition, native buffalo grass at the site will be retained rather than replaced with St. Augustine grass that requires approximately twice the water. The approximately 50,000-gallon rainwater collection and utilization system includes the following.

- Cisterns to collect rainwater
- Gutter system to direct water to cistern
- Interconnection of all cisterns with a piping loop to equalize water levels in each tank and have one system
- Circulation system for freeze protection
- Backup tie-in to city water with automatic fill of no more than one day usage
- Chemical treatment, chlorine tablet
- Pumping system to ensure good mixture of water in cisterns and not just mixture in loop.
- Booster system tied into loop for flushing
- A clear graduated cylinder in hall for students to observe level of water in the system.

Resource Materials Utilization

HVAC Systems

Basic System	Total Wt. Metal (Lbs.)	Total Wt. Non-Metal (Lbs.)	Water (Gal/Yr)	Chemicals (Lb./Yr)	Refrigerant (Lbs.)	Distance (miles)
Pkg Rooftop Units						
Split System Units						
Central Chiller/Hot Water-Water Cooled Chiller						
Geothermal Heat Pump System						

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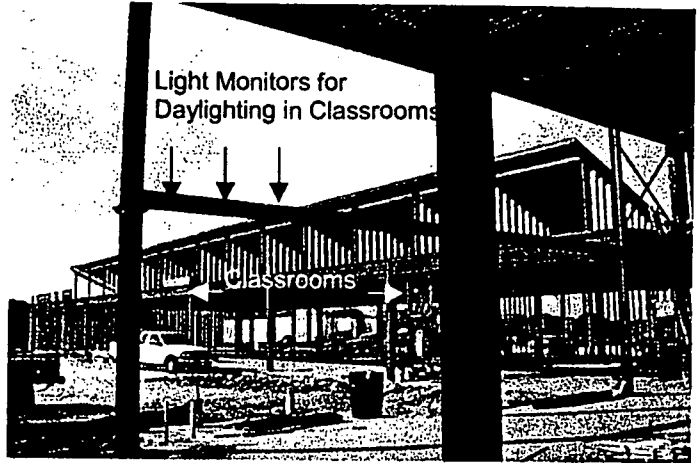
Figure 5: Resource/Materials Utilization

RECOMMENDATIONS

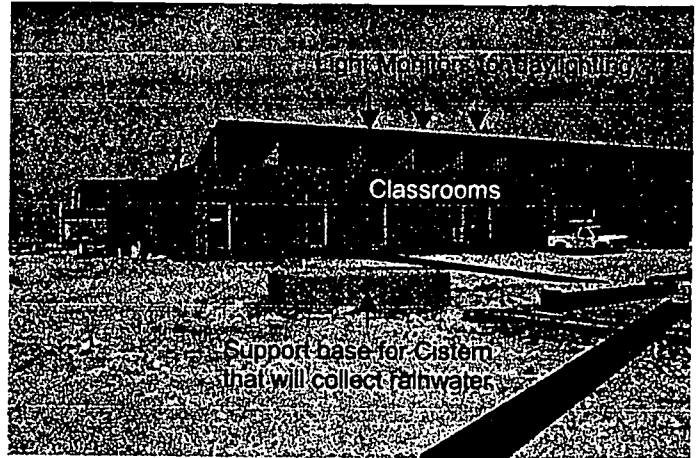
1. Dr. Anthony, McKinney ISD Superintendent has recommended that multi-dimensional research be conducted to determine the overall benefits of McKinney ISD's new sustainable elementary school. A longitudinal study including follow-up of students for a selected number of years, with a comparison to other new McKinney ISD schools without sustainability as a prime criterion.
2. McKinney is a growing community and plans to build more schools. The school board, Dr. Anthony, Dr. Cockrill, Mr. Wyndol Fry, and the taxpayers of McKinney ISD are to be commended for their leadership in funding and promoting the sustainability features of the elementary school.
3. McKinney ISD is planning to build additional elementary schools and they will all be energy efficient and include some sustainable features. A great opportunity will be missed if McKinney ISD is not provided some financial support to include sustainability in these new schools and to fund all of the features in at least one school.

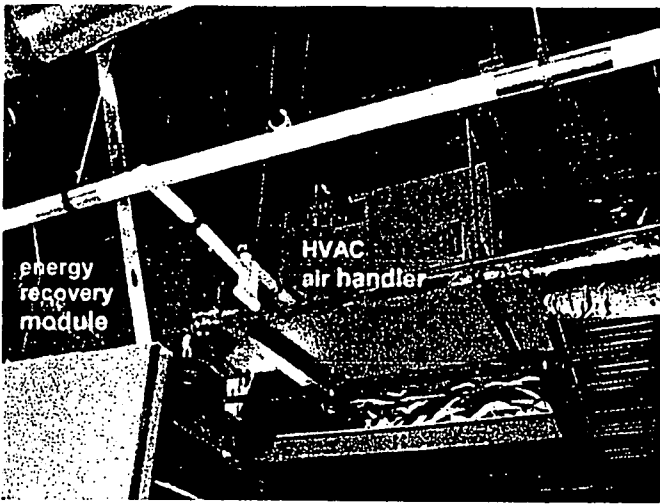
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3. "Resource/Materials Utilization, HVAC Systems", Copyright 1998, reproduced with permission from Estes, McClure & Associates, Inc.
4. Estes, Jim, "Performance and Experience of a Flat Plate Absorber Operating in a Vacuum", 1977, ERDA Conference - Florida

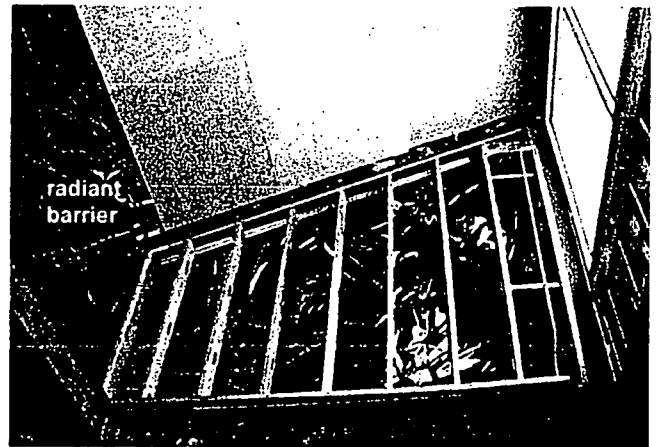
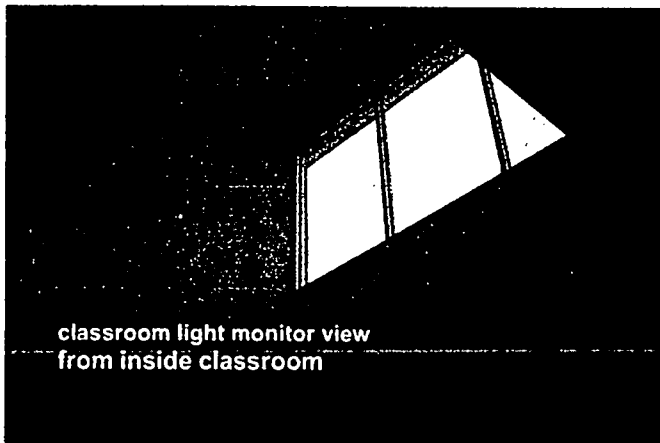


**McKinney ISD Sustainable Elementary School
December 1, 1999**

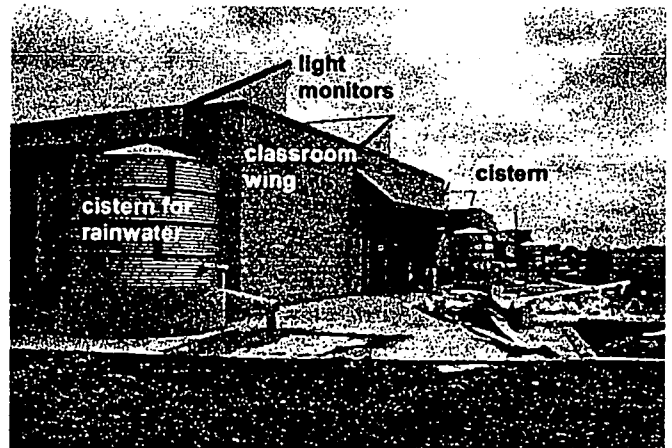
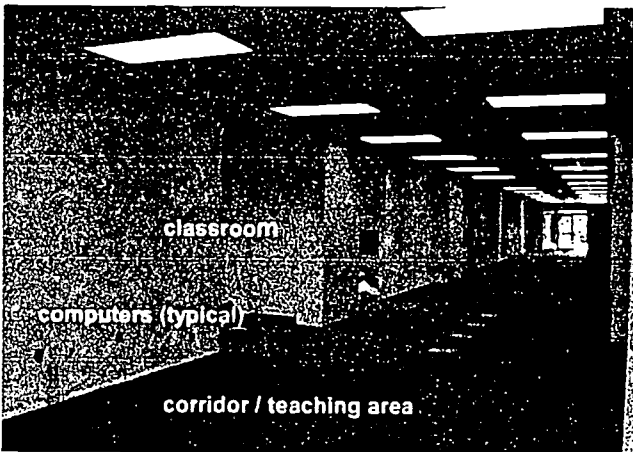




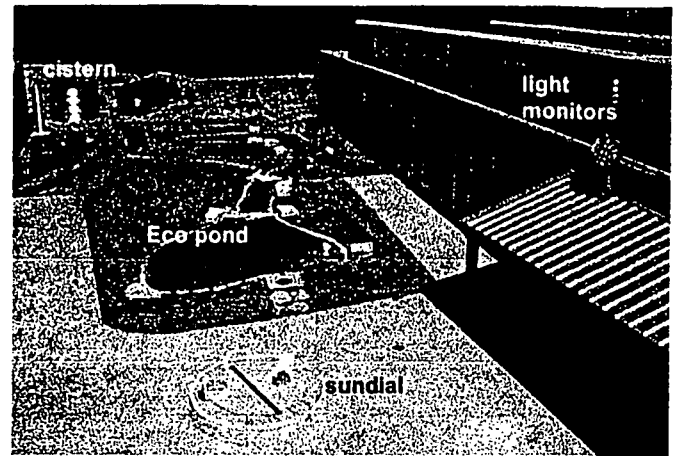
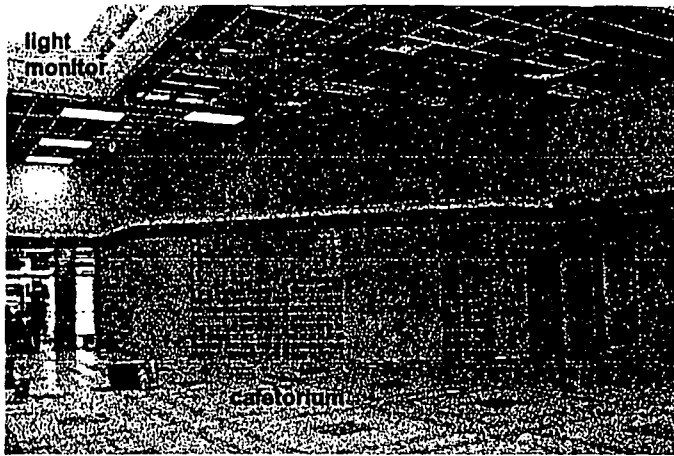
McKinney Sustainable Elementary School



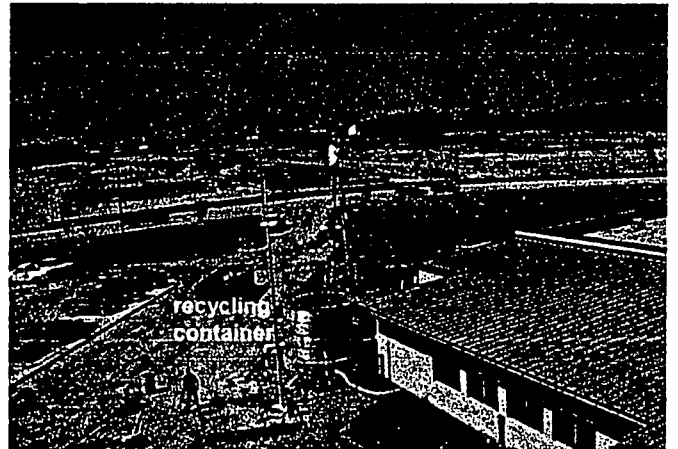
March 23, 2000



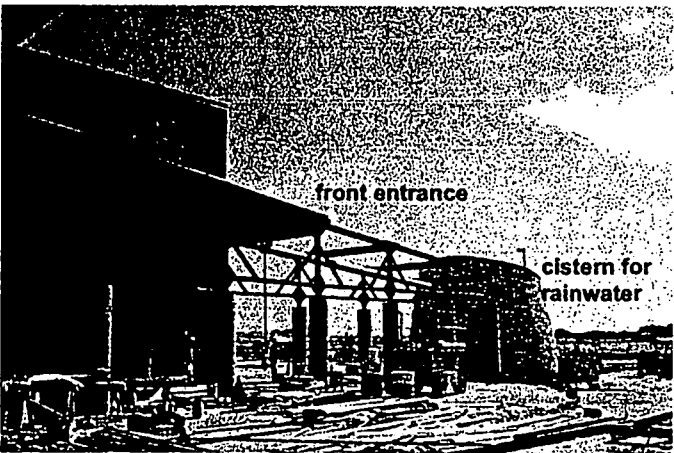
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McKinney Sustainable Elementary School

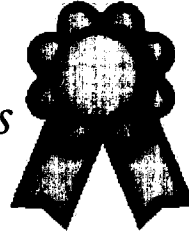


June 2, 2000



Presented at the Twelfth Symposium on Improving Building Systems in Hot and Humid Climates – May 16, 2000
 Sponsored by Texas A & M University, Texas State Energy Conservation Office, Department of Energy, and others.

Awards & Honors



*Roy Lee Walker Elementary
McKinney Independent School District
McKinney, Texas*

2001 National School Boards Association Exhibition of
School Architecture
Citation Award of Architectural Excellence

2000 American Association of School Administrators,
American Institute of Architects, and the
Council of Educational Facility Planners International
Shirley Cooper Award

1999 The American Institute of Architects
*Earth Day Top Ten Environmentally-Responsible
Design Solutions*



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