SUSTAINABLE FEATURES OF McKINNEY ISD ELEMENTARY SCHOOL

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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.

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Mechanical, Electrical, Plumbing, Energy and Sustainability
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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.

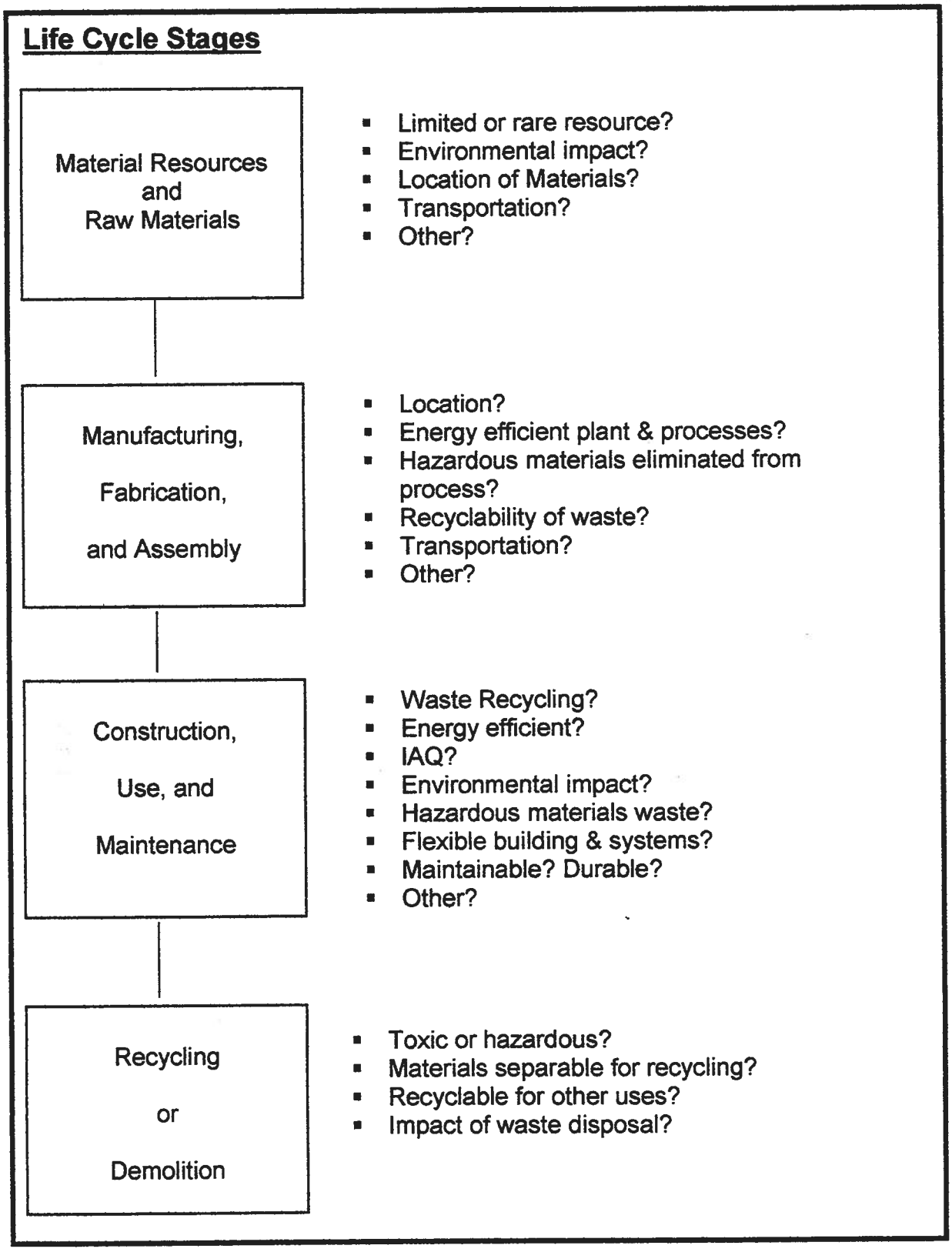

Figure 1. Life Cycle Stages

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 CO_2 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:

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

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						

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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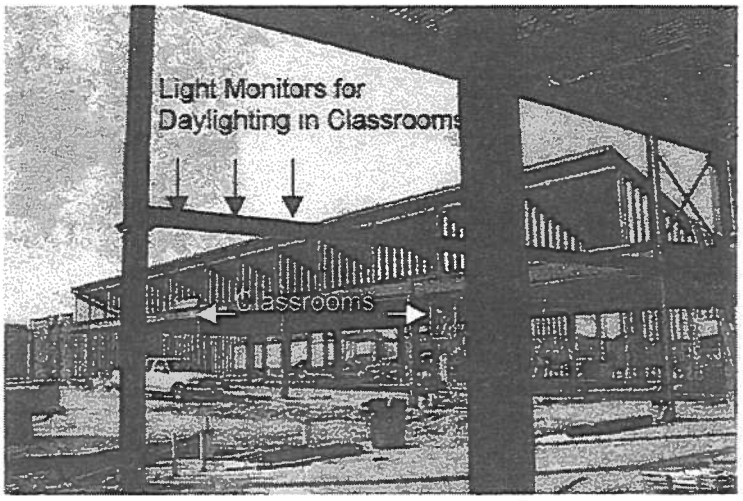

McKinney ISD Sustainable Elementary School
December 1, 1999