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ABSTRACT

Design information, floor plan, photos, and energy use data are presented of a combined 45,000 square foot junior/senior high school in Mississippi's Aberdeen School District, built in 1956, and retrofitted over time to improve its usability. Exterior and interior photos are presented showing classrooms, the cafeteria, and gymnasium. Data are presented on the school's current energy use and every area where improvements are required. Lighting retrofit information and cost/savings data on a geothermal heat pump retrofit conclude the document. (GR)

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Case Study in Sustainable Design

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Jeffery Lackney

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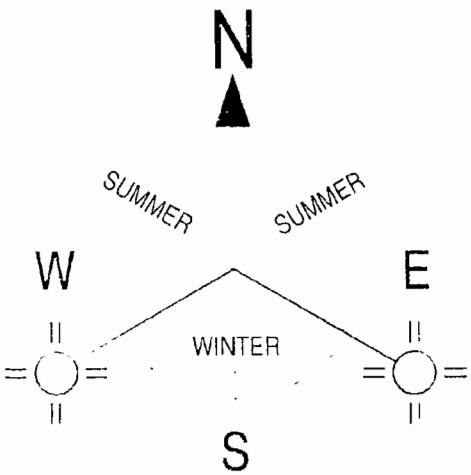
Shivers Junior/Senior High School

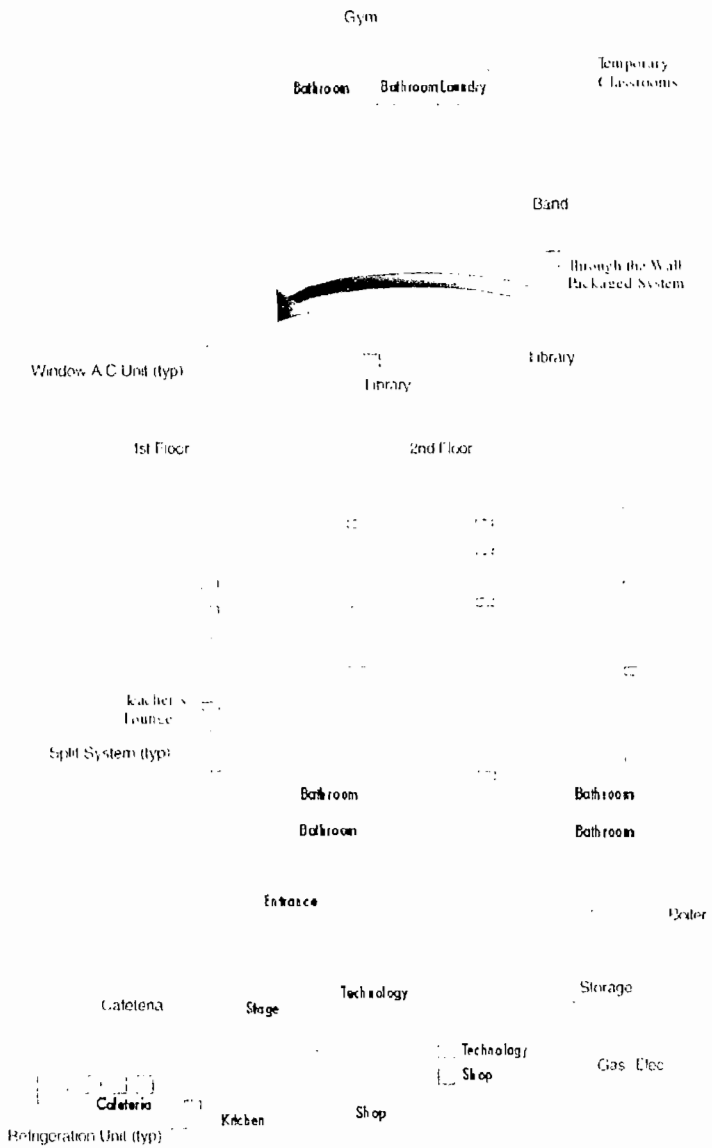
Basic Description:

- Combined Junior/Senior High School in the Aberdeen School District in Mississippi
- Built in 1956, 45,000 sf brick & block construction, 667 students
- Single glazed windows, little or no insulation
- Originally hot water heat heating & natural ventilation cooling.
- Retrofitted over time with window and package AC units
- 1950's fluorescent light fixtures with T-12 lamps and magnetic ballasts

Shivers Junior/Senior High School

Floor Plan:





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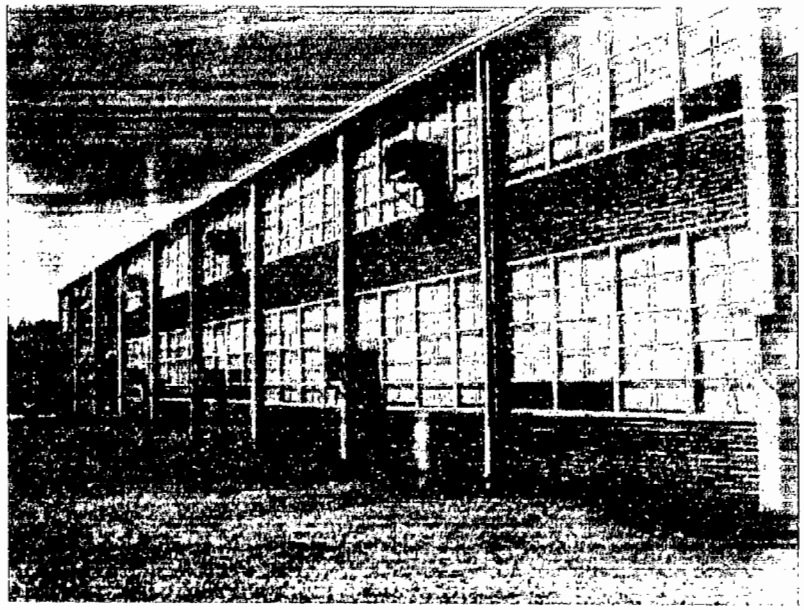
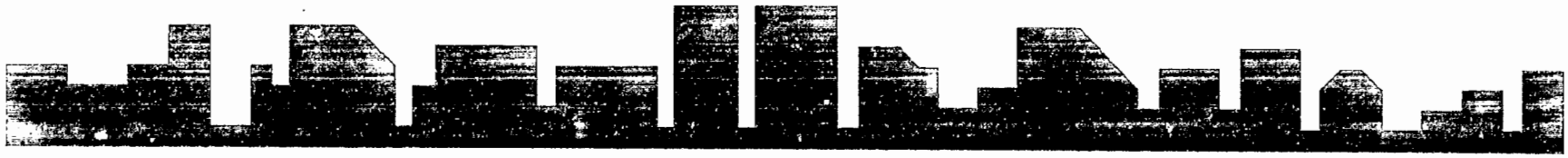
Shivers Junior/Senior High School

Exterior Photos – Classroom Wing

East Elevation



East Elevation

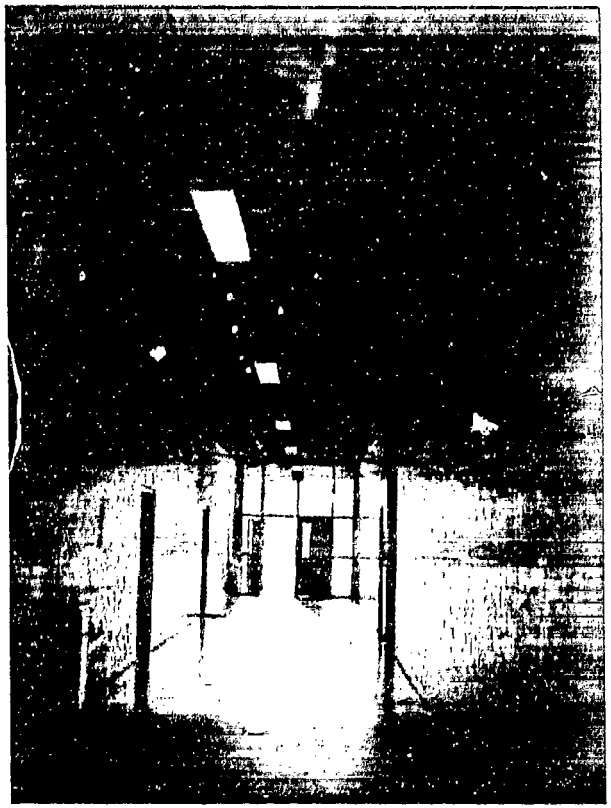


Shivers Junior/Senior High School

Interior Photos – Classroom Wing

Typical Classroom

Hallway->



Shivers Junior/Senior High School

Exterior Photos – Cafeteria & Kitchen

South Elevation

Closed windows & HVAC retrofit

Shivers Junior/Senior High School

Interior Photos – Cafeteria & Kitchen

Shivers Junior/Senior High School

Photos – Gymnasium

South Elevation

Interior

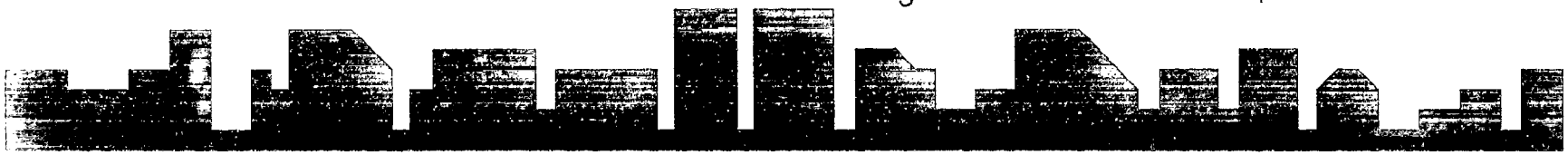
Shivers Junior/Senior High School

Current Energy Use:

Energy Source	Annual Energy Use - $s	Energy Use Category	Estimated Yearly Energy Use	
			% of total	Cost - $s
Natural Gas	$4,600	Space Heating	68%	$3,128
		Hot water heating	17%	$782
		Cooking	13%	$598
Electricity	$21,750	Lighting	58%	$12,615
		Cooling	20%	$4,350
		Equipment	9%	$1,958
		Fans/motors	7%	$1,523
		Refigeration & cooking	4%	$870
		Water Heating	2%	$435
TOTAL				**$26,258**

divided by 45,000 sf = $0.58 /sf

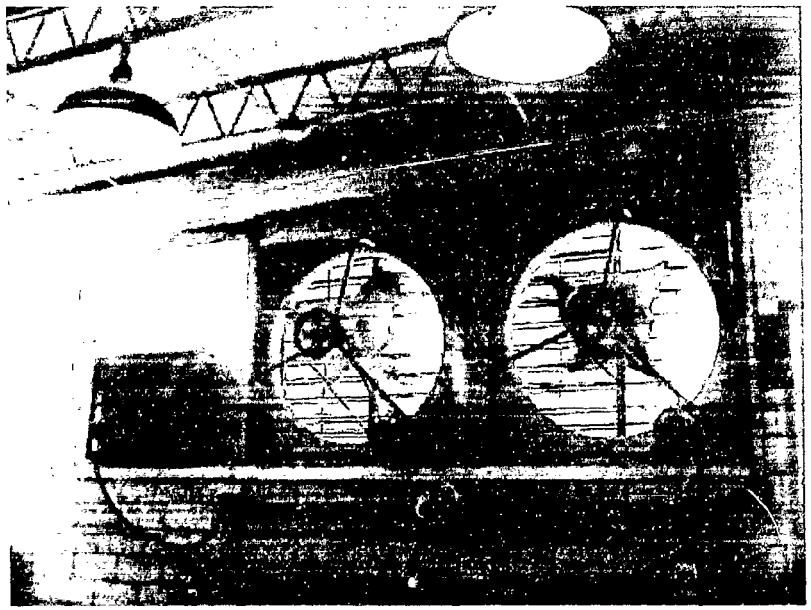
Average school uses -> $1.20 /sf



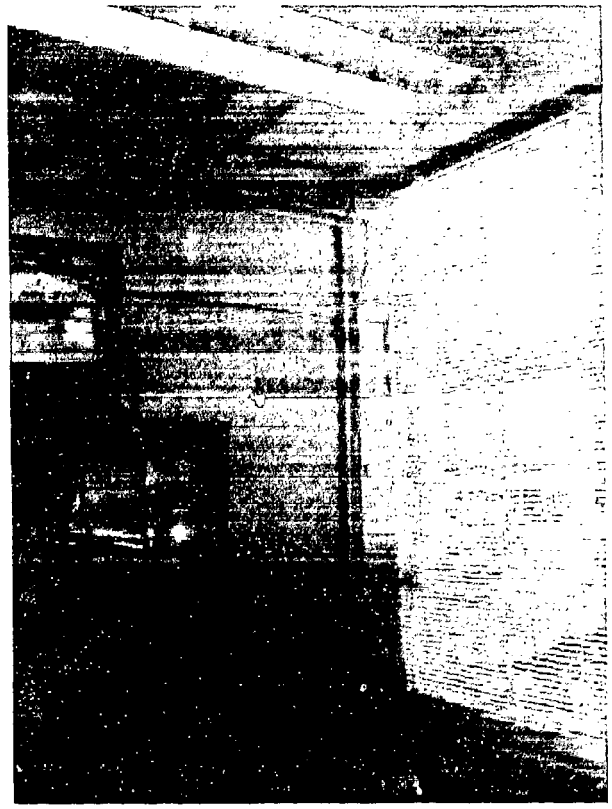
Shivers Junior/Senior High School

Opportunities for improvement:

- Inefficient HVAC systems



Window AC units w/ vent fans

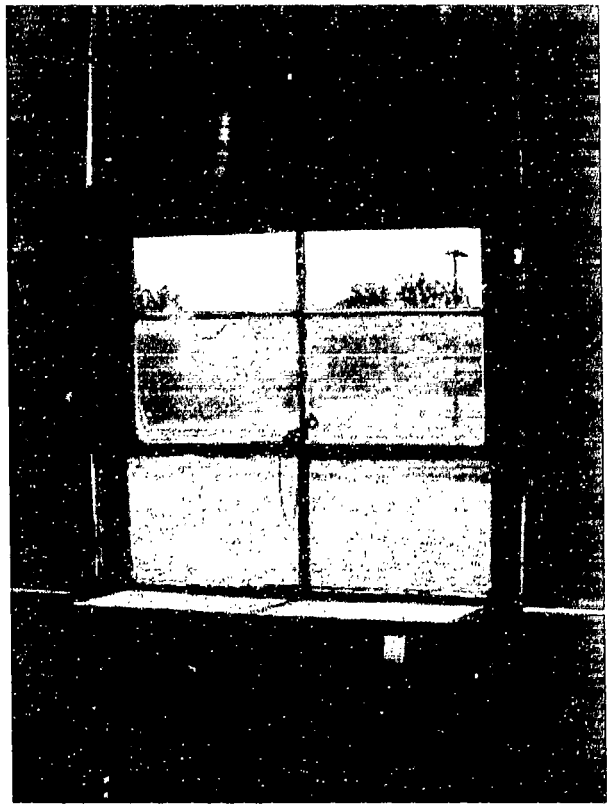


Hot water fan coil units

Shivers Junior/Senior High School

Opportunities for improvement:

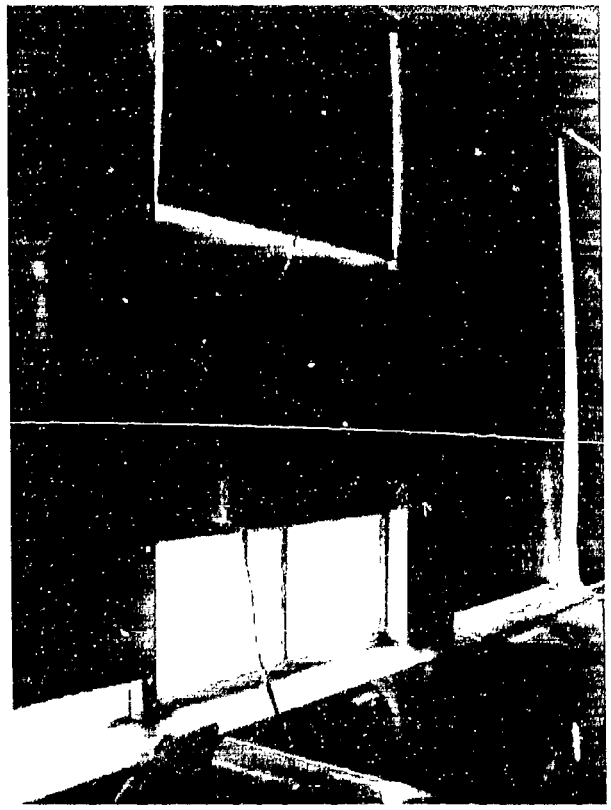
- Inadequate ventilation when cooling – ventilation option closed on window AC units
- Leaky envelope



Shivers Junior/Senior High School

Opportunities for improvement:

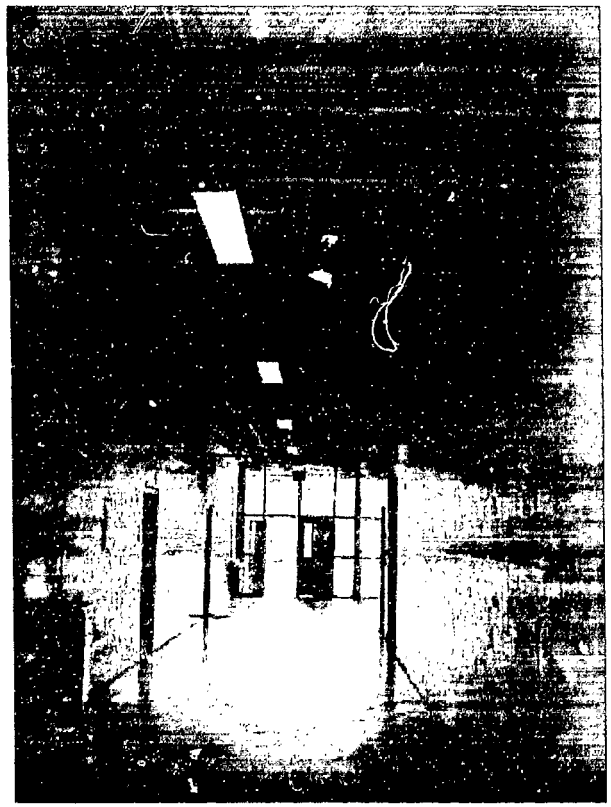
- Excessive glare in classrooms – blinds shut most of time



Shivers Junior/Senior High School

Opportunities for improvement:

- Poor hallway lighting



Shivers Junior/Senior High School

Opportunities for improvement:

- Poor inefficient lighting

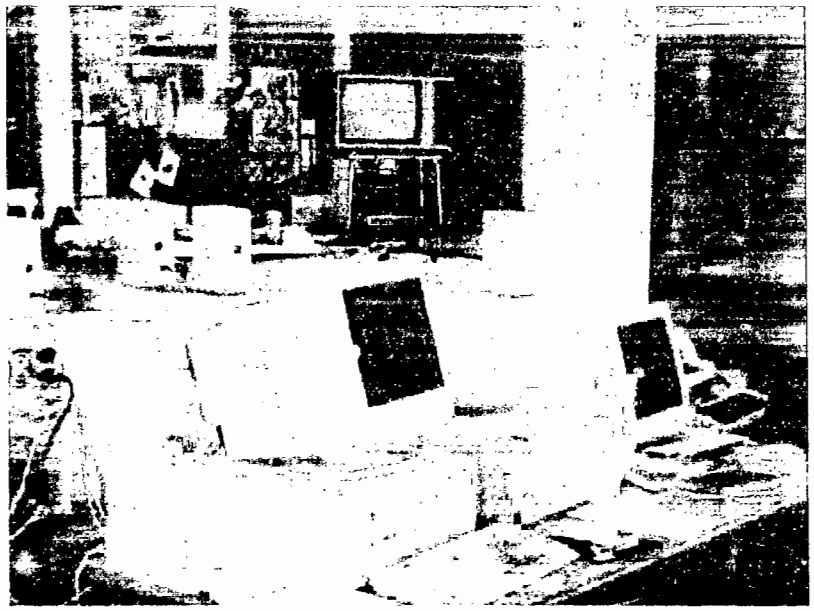
Library lighting

1950 fluorescent light fixtures

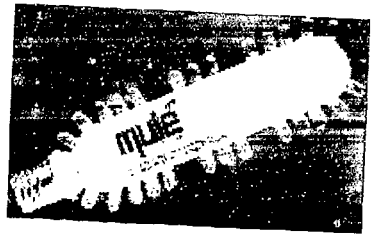
Shivers Junior/Senior High School

Opportunities for improvement:

- Inadequate electrical wiring in classrooms for computers and other equipment



Shivers Junior/Senior High School
Lighting Retrofit – LED exit lights



	a	b	c	d=b x c	e=a x d/1000	=e x $0.0805/Kwh
	Watts per sign	Hours use per day	Days/yr	Total Hours	Total Kwh/yr	$s/year
Standard Exit Sign	20	24	365	8760	175	$14
LED Exit sign	2	24	365	8760	18	$1
SAVINGS/year						$13
Labor savings						$20
TOTAL SAVINGS						$33

Cost Analysis

a	b	c=b/a
SAVINGS	Cost of LED lamps	Payback-years
$33	$22	0.7

Shivers Junior/Senior High School

Lighting Retrofit – T8 lamps & Electronic Ballasts

Number of fixtures

a	b	c=a x b	d	=c/d
Floor area lit by fluor.	Existing watts/sf	Total Watts	Watts/fixture 2-4' lamps & Mag ballast	No. of Fixtures
45000	1.6	72000	84	857

Annual Energy Use - Existing Lighting System

a	b	c=a x b	d	e	f	g=c x d x e x f/1000	=g x $0.0805/Kwh
No. of Fixtures	Watts/fixture 2-4' lamps & Mag ballast	Total Watts	Hours day	Days Week	Weeks Year	Kwh Year	$/year
857	84	72,000	10	5	44	158,400	$12,751

Annual Energy Use - Efficient Lighting System - T8 lamps + electronic ballasts

a	b	c=a x b	d	e	f	g=c x d x e x f/1000	=g x $0.0805/Kwh
No. of Fixtures	Watts/fixture 2-4' T-8 lamps & elec. ballast	Total Watts	Hours day	Days Week	Weeks Year	Kwh Year	$/year
857	53	45,429	10	5	44	99,943	$8,045

Net savings	$4,706

Cost Analysis

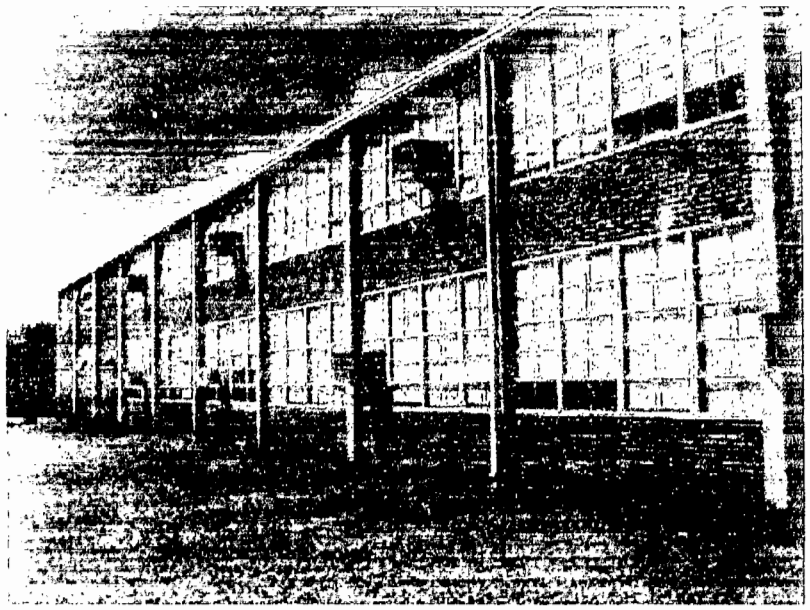
a	b	c	d	e	f=a x (b+c+d+e)
No. of Fixtures	Lamp cost per fixture	Electronic Ballast Cost	Ballast & Lamp recycling Cost	Labor to retrofit fixture	Total Cost
857	$4.00	$18.00	$5.40	$15.00	$36,343

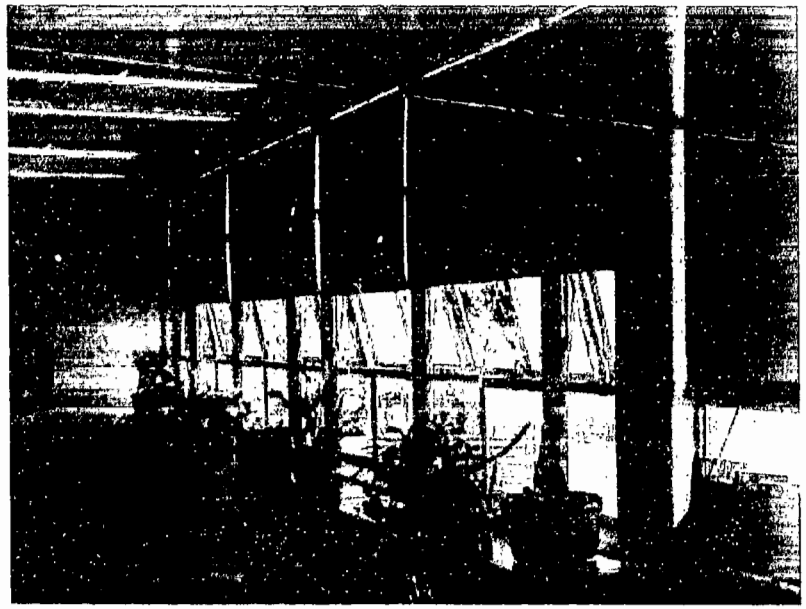
cost/savings
Payback - years
7.7

3,

Shivers Junior/Senior High School

Lighting Retrofit – Daylighting

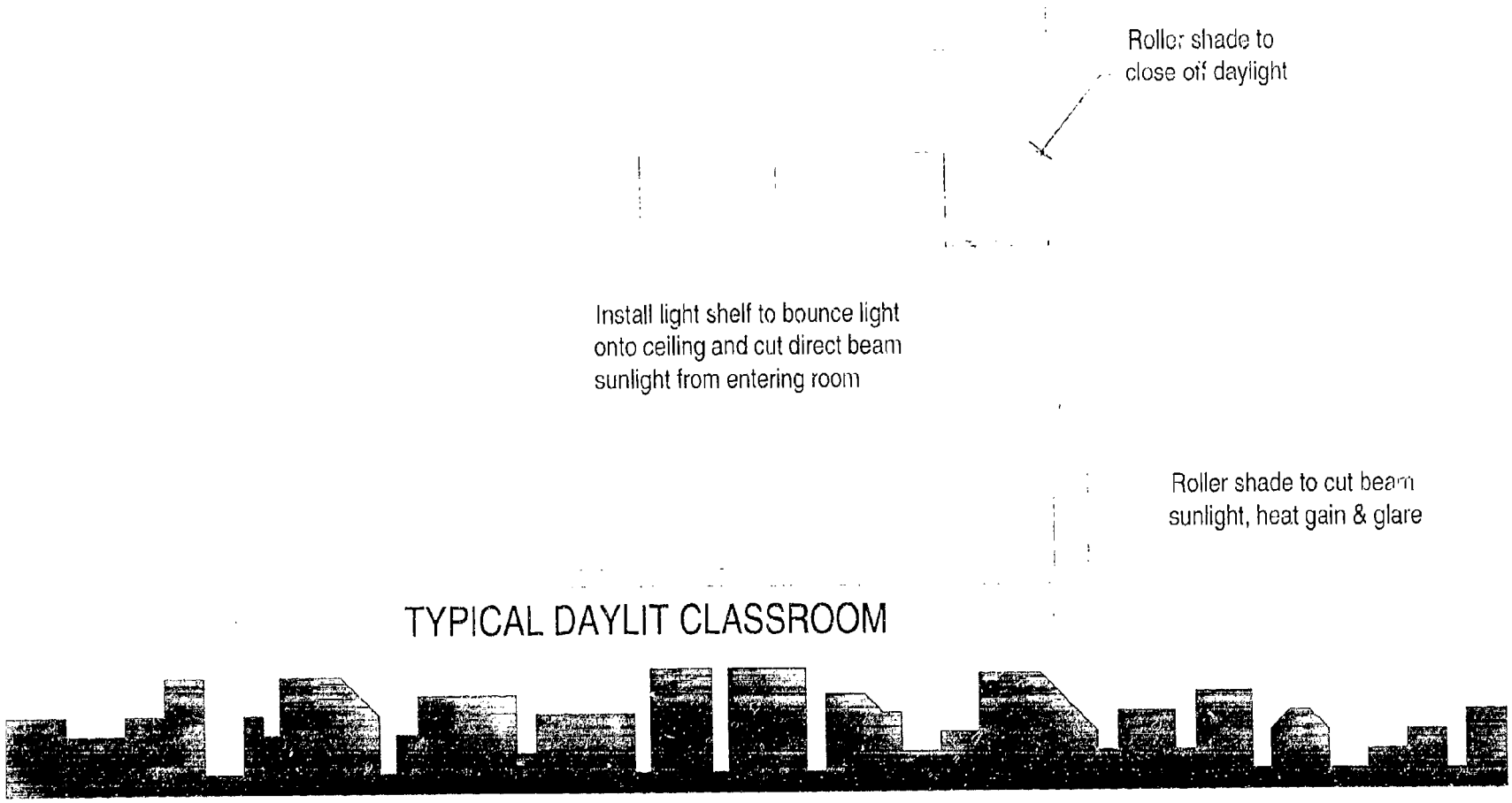




Blinds are shut on almost all the windows because of solar heat gain & glare

Shivers Junior/Senior High School

Lighting Retrofit – Daylighting



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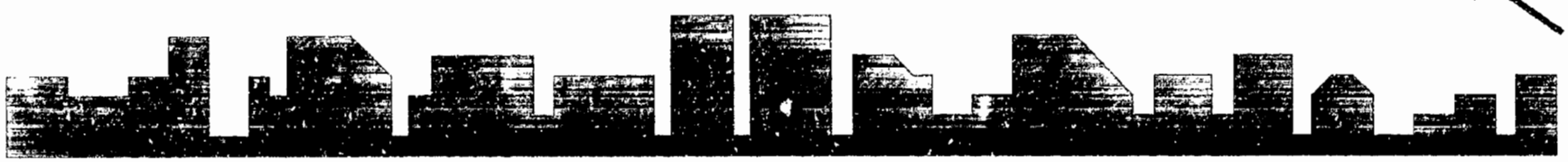
Lighting Retrofit – Daylighting

Daylight savings

a	b	c=b x 45,000	d=a x b	e	f=d x e
$/year spent on lighting	% of building that could be retrofitted for daylighting	sq ft of bldg that could be retrofitted for daylighting	$/year lighting that could be impacted by daylignting	% savings due to daylighting	Potential Daylit savings
$12,615	30%	13,500	$3,785	60%	$2,271

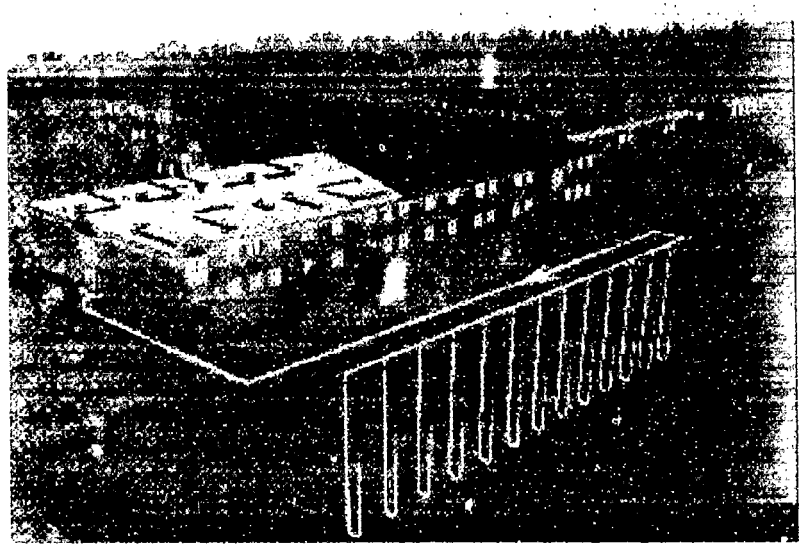
Cost Analysis

a	b=19 class rooms x 28' 3' x $4.50/sf	c=19 class rooms x 28' x2.5' x $1.76/sf	d=b+c	c=b/a
SAVINGS	Cost of light shelves	Cost of upper roller shades above light shelfs	Total Cost	Payback-years
$2,271	$7,182	$2,341	9,523	4.2



Shivers Junior/Senior High School

HVAC Retrofit – Geothermal Heat Pump



-Transfers heat out of the ground and into the classrooms in winter.
-Transfers coolness out of the ground and into the classrooms in summer.
-Very efficient and very environmental HVAC System.
-Uses minimum amounts of space, no boiler and chiller.
-Low maintenance

Shivers Junior/Senior High School
HVAC Retrofit – Geothermal Heat Pump

Geothermal heatpump savings

	a	b	c	d	e=b x c	f	g=a x f	h=e+g
	sq ft	Total Energy Cost/year	Heating & cooling Cost/year	Average Geothermal savings-%	Potential Yearly savings-$	Typical Maint. Savings $/sf	Yearly Maint. Savings $s	Total Savings
Shivers High School	45,000	$26,350	$7,478	40%	$2,991	$0.05	$2,250	$5,241

Geothermal Heatpump Cost

School	Year Built	Climate	HDD	CDD	a sq ft	No. of Students	b GSHP Cost - $	c=b/a $/sf	Tons	Tons/sf
Boone High School	1971	Tri-Cities	4306	1107	161,000	1,100	451,000	2.80	400	403
Shivers High School	1956	Jackson, MS	2300	2316	45,000	667	126,056	2.80	112	403
							d=a x c			

Cost Analysis

-calculated for Shivers

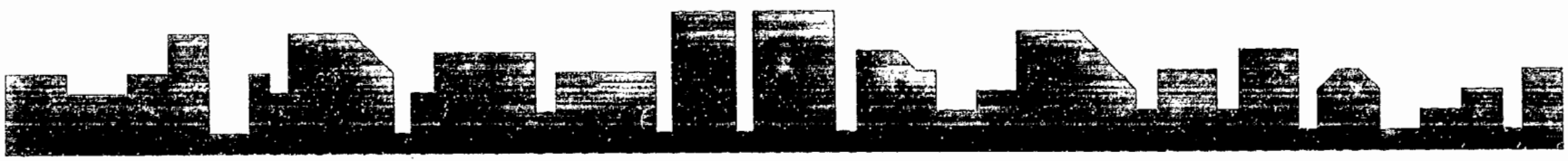
a SAVINGS	b Cost of geothermal System	c=b/a Payback -years
$5,241	$126,056	24

Shivers Junior/Senior High School

Other Energy Conservation Opportunities to consider:

- Occupancy sensors – quick payback
- Exterior Shade Screens – quick payback
- Night setback and setup thermostats – quick payback
- Roof insulation / light colored roof – cost effective during re-roofing
- Wall insulation – very long payback
- Insulated windows – interior storm windows – medium payback, new windows – very long payback

Shivers Junior/Senior High School

Summary:

- Need to reuse existing buildings and existing brown field sites.
- When we upgrade buildings we need to make them more functional and energy efficient.
- If we do have to build new we need to recycle materials and chose more sustainable building materials.