Metropolitan Washington Council of Governments (COG)

Energy and Built Environment Committee (BEEAC)

Presenter: Bruce E. Beddow, PE, CEM, GBE

b2E Consulting Engineers, PC

CASE STUDY – INSTALLED 2008

GEO-SOLAR HEAT PUMP SYSTEM
MINNIE HOWARD SCHOOL

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HEALTHY LEARNING ENVIRONMENTS

Green Building Initiatives

A platform for student education.

by BRUCE REDDOW, PE

WITH STUDENTS FROM 80 countries speaking more than 60 different languages, Alexandria City Public Schools (ACPS), Alexandria, Va., is one of the most diverse school systems in the country. The City of Alexandria was recently named one of the Top 100 Communities for Young People by America's Promise Alliance, a partnership founded by Colin and Alma Powell that is committed to childhood education. Families move to Alexandria because of the quality of the school programs. With 19 schools spanning pre-kindergarten to 12th grade, ACPS has always enjoyed tremendous community support and has implemented energy conservation and earth-friendly practices for years.

In 2008, ACPS officials realized that many of the school district's buildings were operating on mechanical systems that were at least a half-century old, and energy costs were adding up. Many schools used antiquated boiler and chiller systems that were both inefficient and costly to maintain. In addition, the lack of ventilation made obtaining an excellent level of indoor air quality difficult.

Believing that a healthy school is as integral to a student's learning environment as the curriculum itself, ACPS decided to look for building initiatives and solutions that would make its buildings healthier

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- COMPARISON CONVENTIONAL 4-PIPE with GEO-SOLAR GSHP SYSTEM

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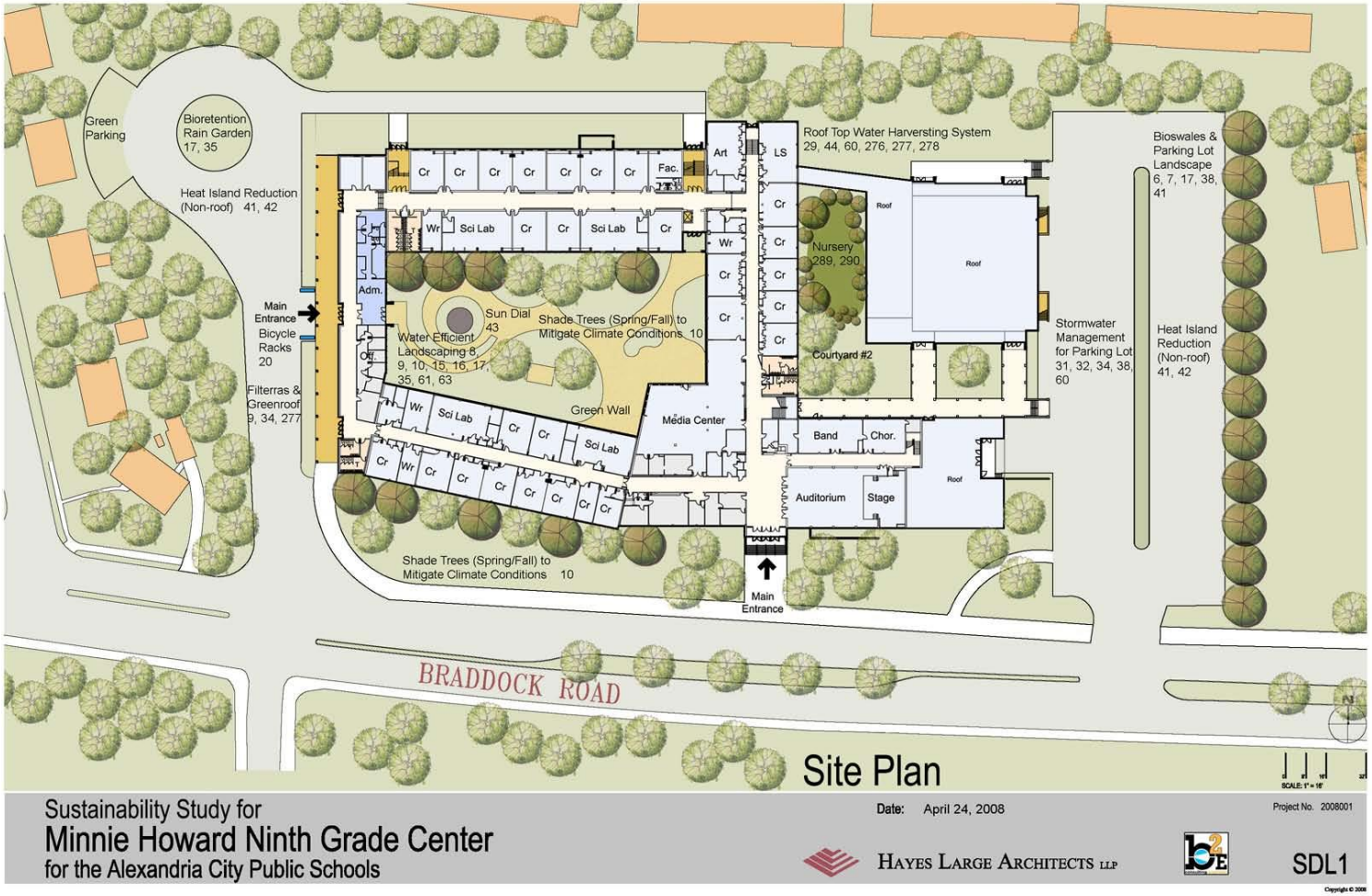
SUSTAINABILITY STUDY: ARCHITECTURE & MEP



SUSTAINABILITY STUDY: ARCHITECTURE

SUSTAINABILITY STUDY: ARCHITECTURE

SD9

SUSTAINABILITY STUDY: ARCHITECTURE

SUSTAINABILITY STUDY
Minnie Howard Ninth Grade Center

HAYES LARGE ARCHITECTS LLP

SUSTAINABILITY STUDY: ARCHITECTURE

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SUSTAINABILITY STUDY
Minnie Howard Ninth Grade Center

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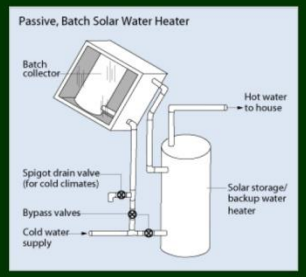
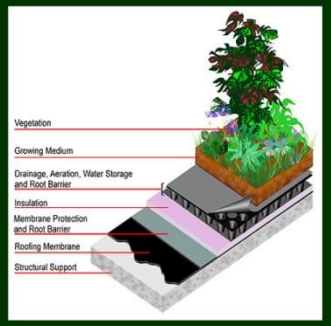
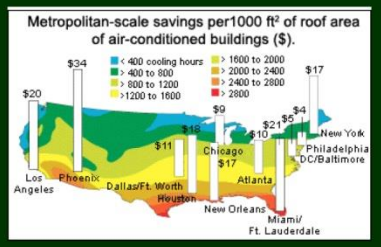
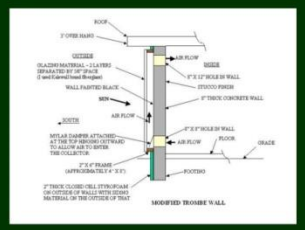
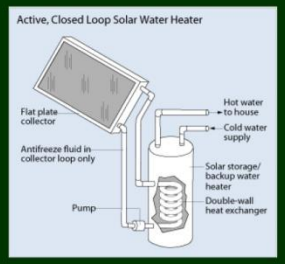
SUSTAINABILITY STUDY: HVAC

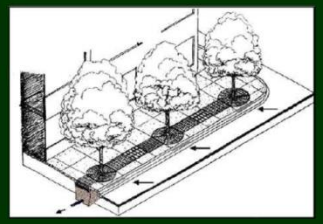


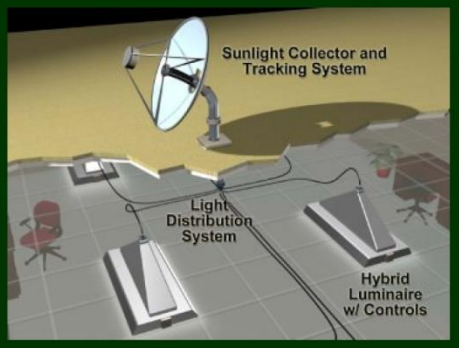


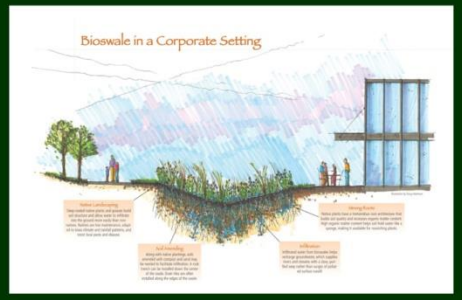












SUSTAINABILITY STUDY

Minnie Howard Ninth Grade Center

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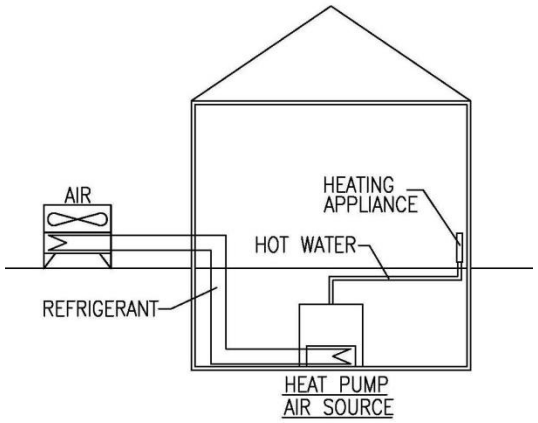
SUSTAINABILITY STUDY: HVAC

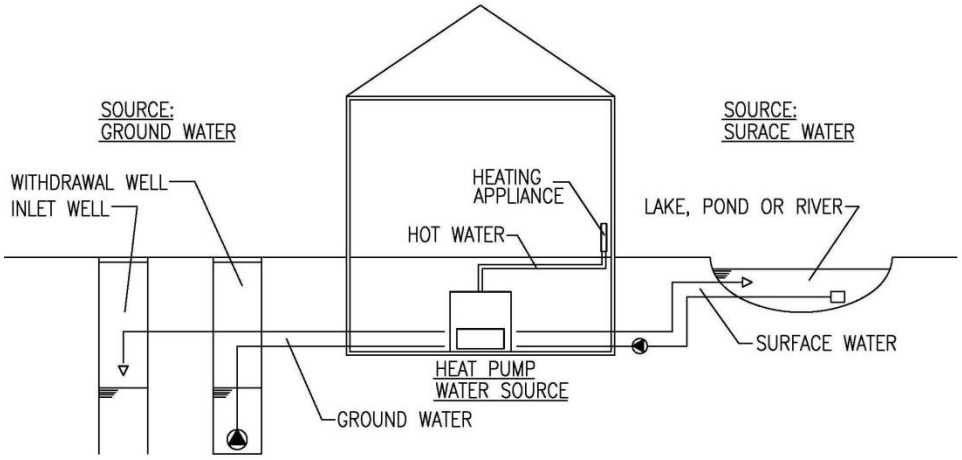
HEAT PUMP

SOURCE: AIR
COP: 2.5 – 3.0



Lower First Cost - Less Efficient

SOURCE: GROUND WATER
COP: 3.0 – 5.0



Higher First Cost - Good Efficiency

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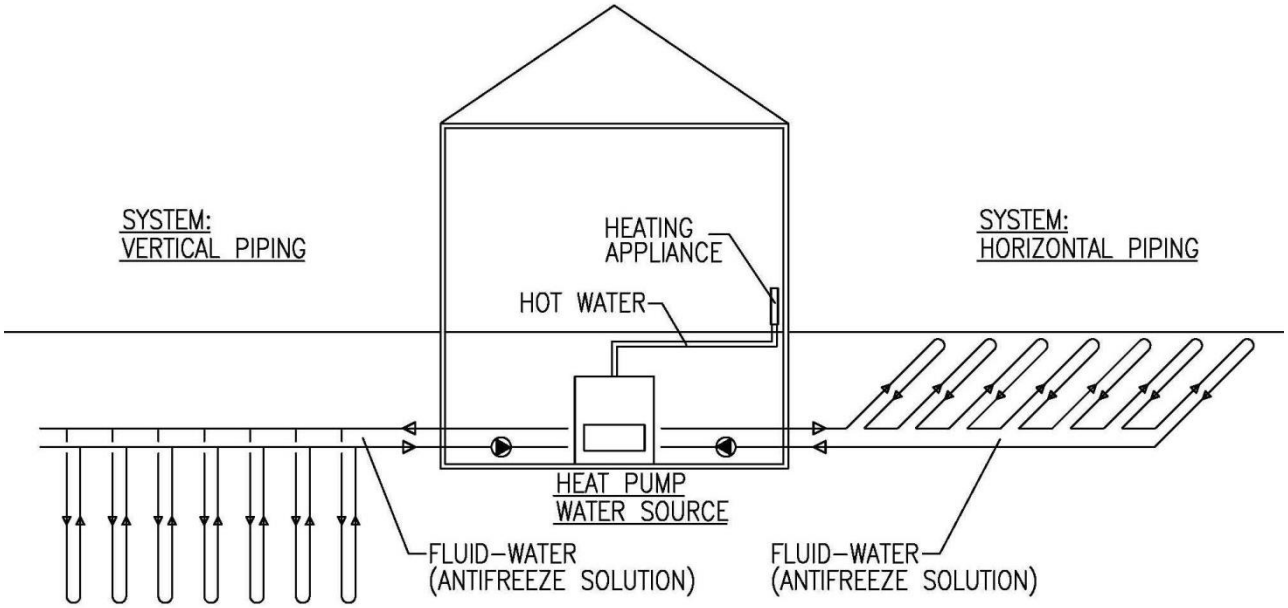
SUSTAINABILITY STUDY: HVAC

HEAT PUMP

SOURCE: EARTH-COUPLED

COP: 4.0 – 7.0

Recommended Solution
Highest First Cost – Better Efficiency



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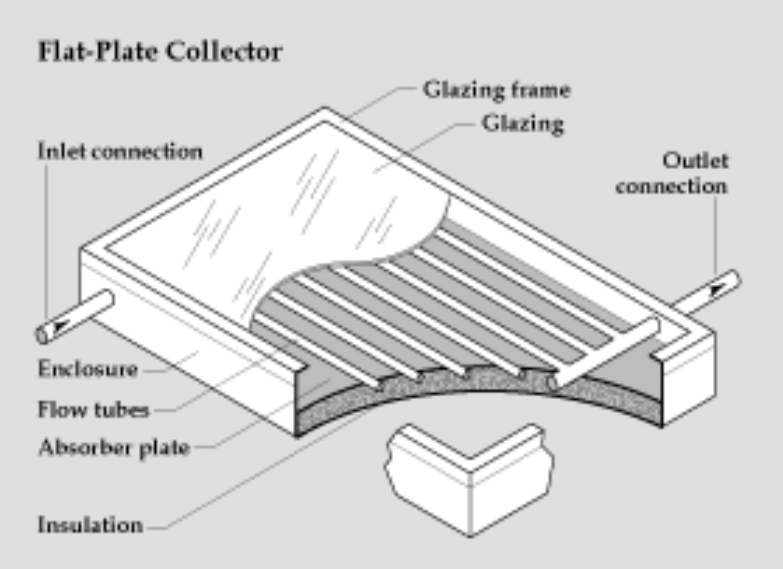
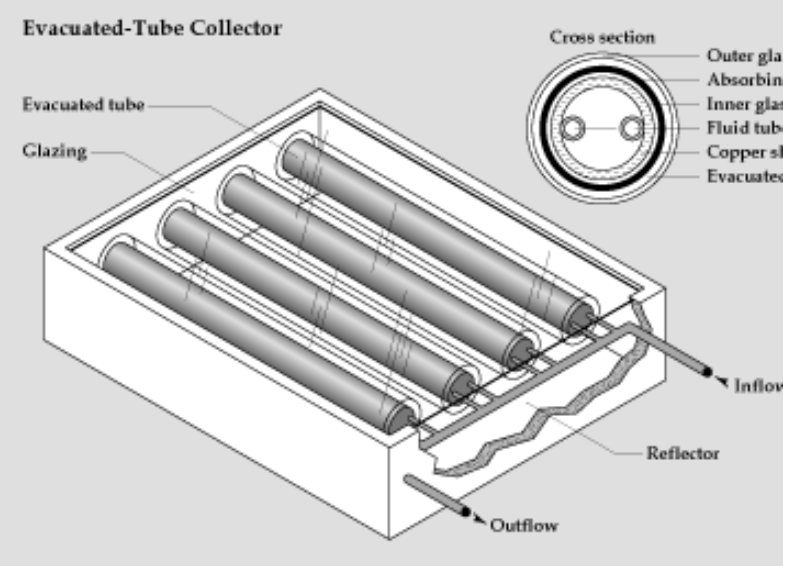
SUSTAINABILITY STUDY: HVAC

DIRECT SOLAR ENERGY

SOLAR COLLECTOR PANEL





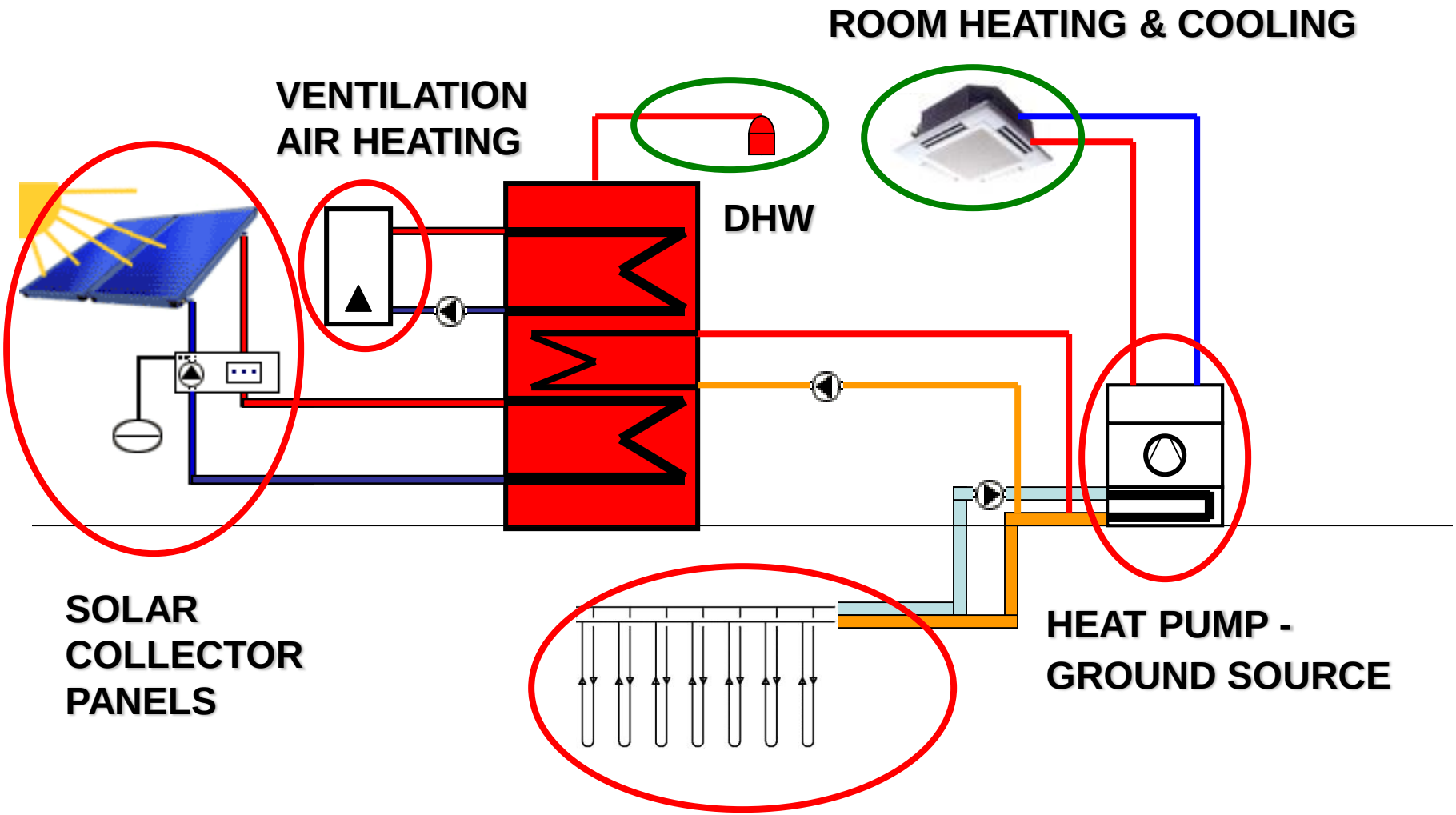
FLAT-PLATE COLLECTOR

- Residential and Commercial
- Temperature below 200°F
- Box is vented to breath and evaporate condensate

EVACUATED-TUBE COLLECTOR

- Temperature higher than 200°F
- Tubes must remain in vacuum or lose efficiency

RECOMMENDED SOLUTION: GEO-SOLAR SYSTEM



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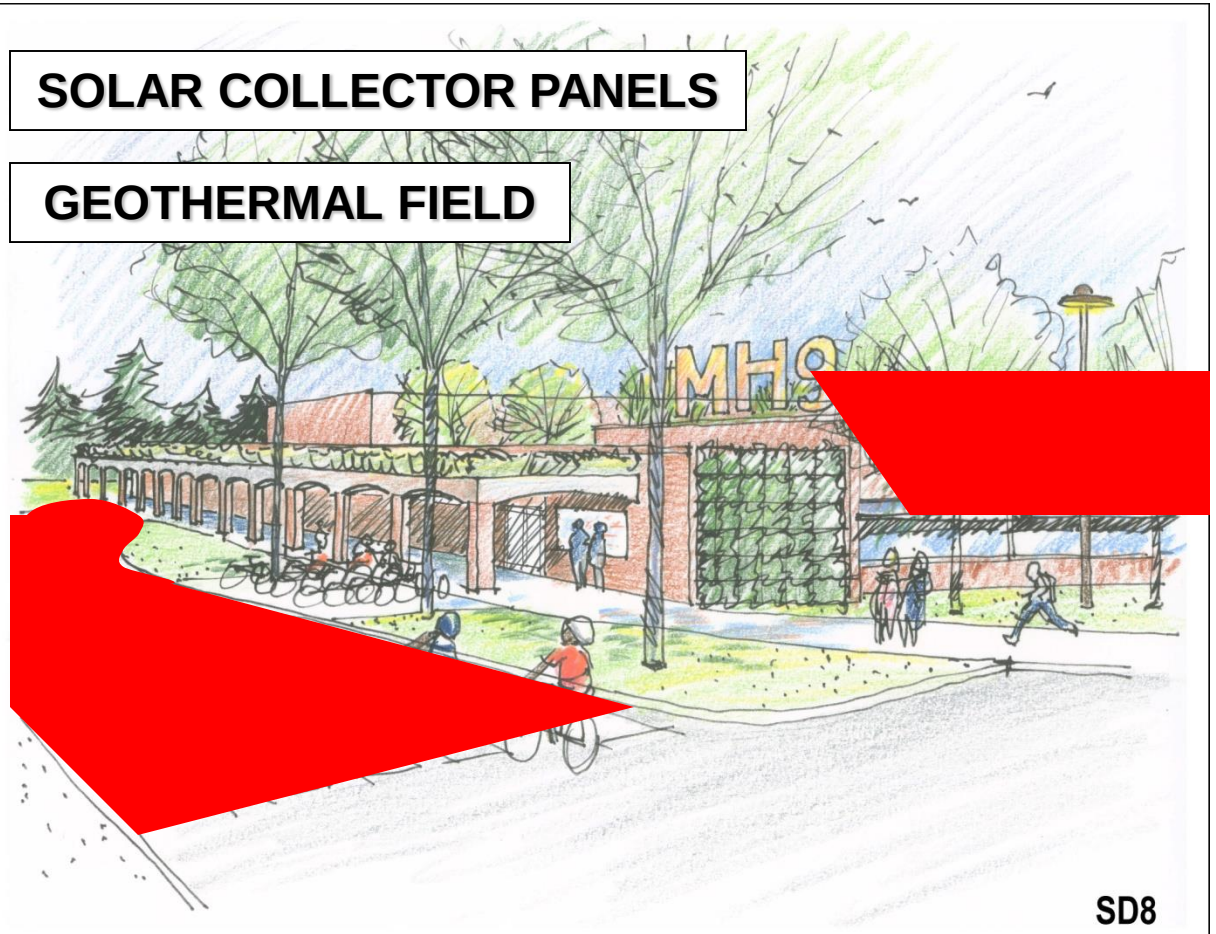

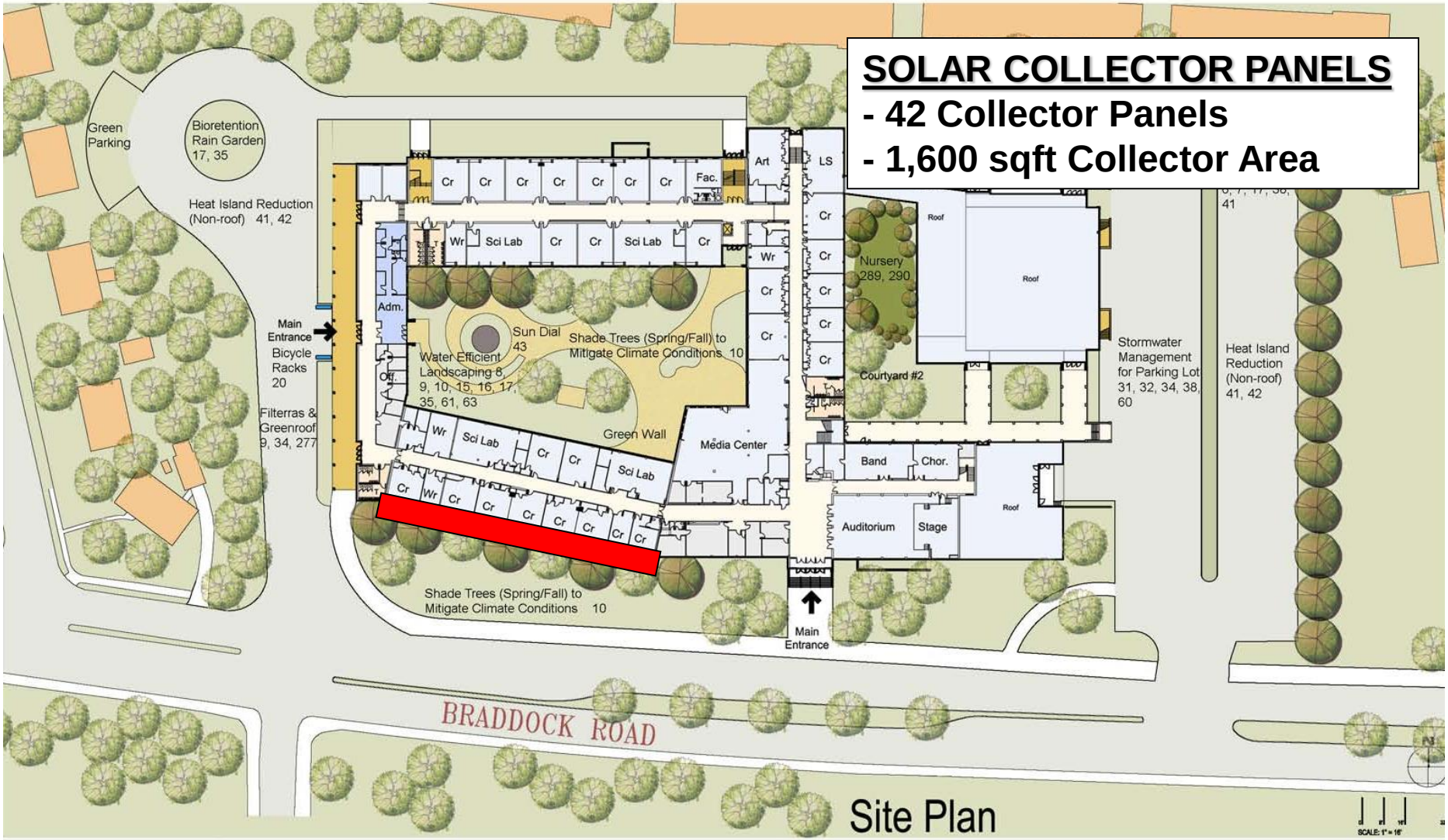

Sustainability Study for
Minnie Howard Ninth Grade Center
for the Alexandria City Public Schools

Date: April 24, 2008

Project No. 2008001

HAYES LARGE ARCHITECTS LLP

SDL1

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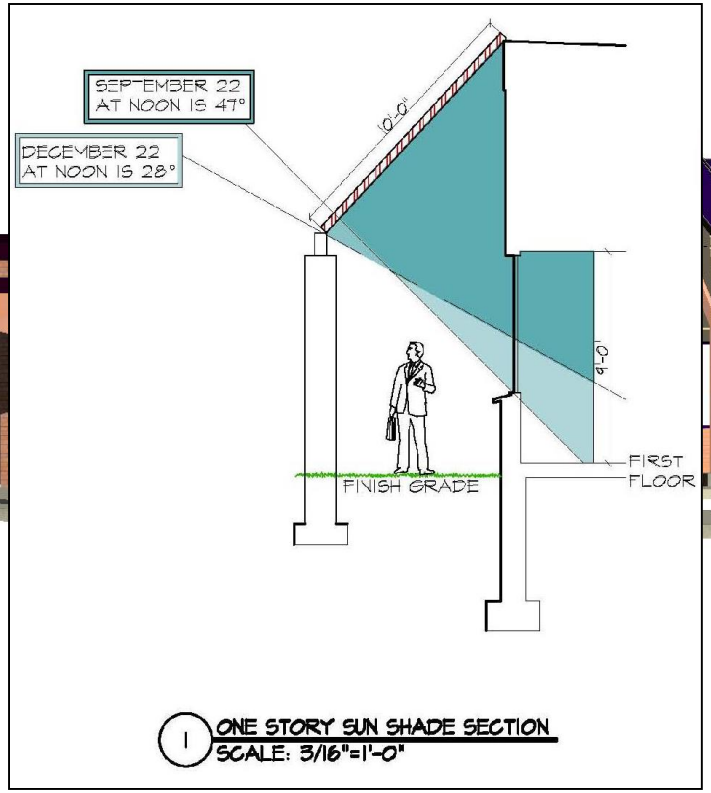
Energy Flow Diagram

LEED EB

APPROVED SOLUTION: GEO-SOLAR SYSTEM

SOLAR COLLECTOR PANELS



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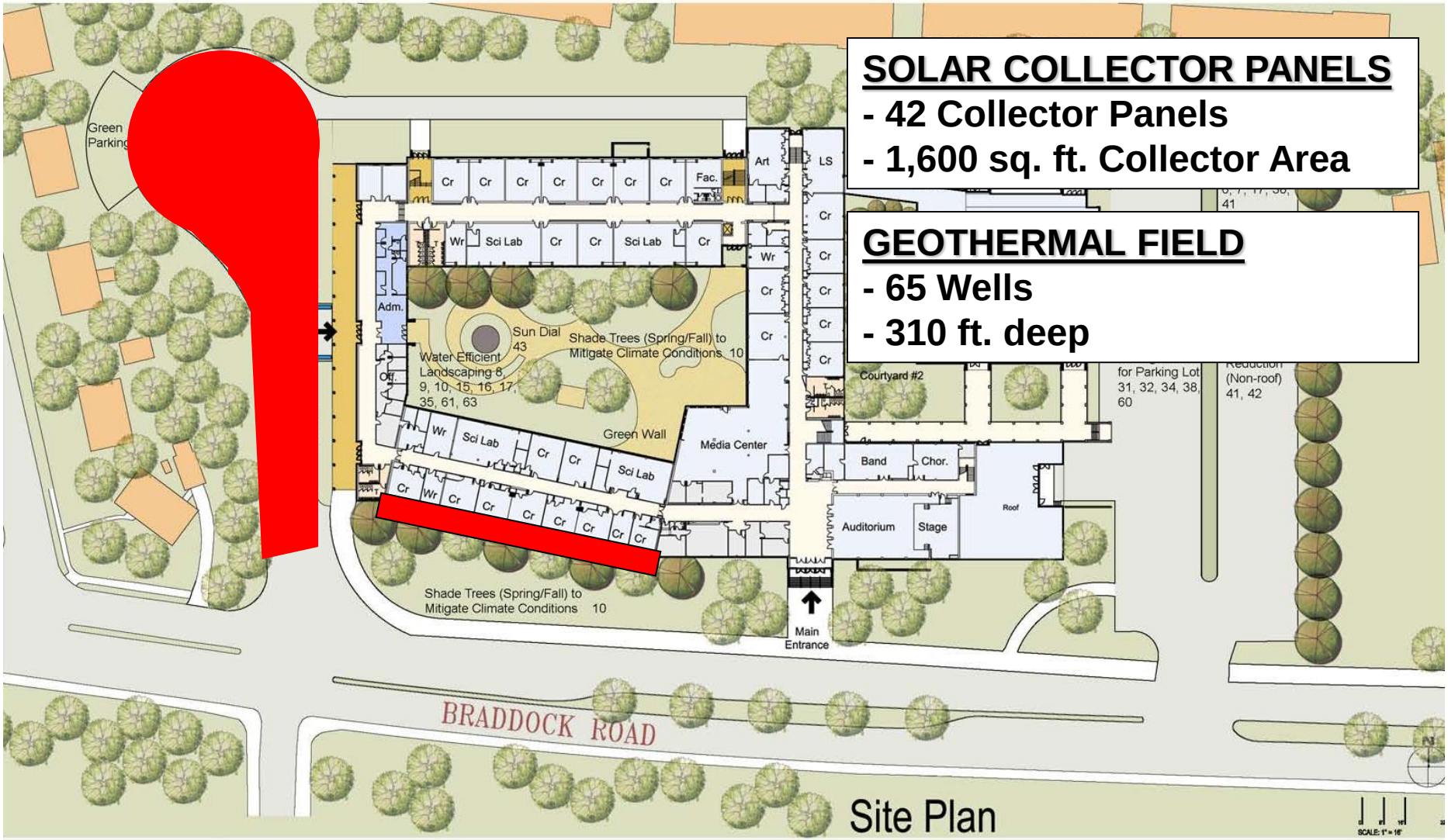

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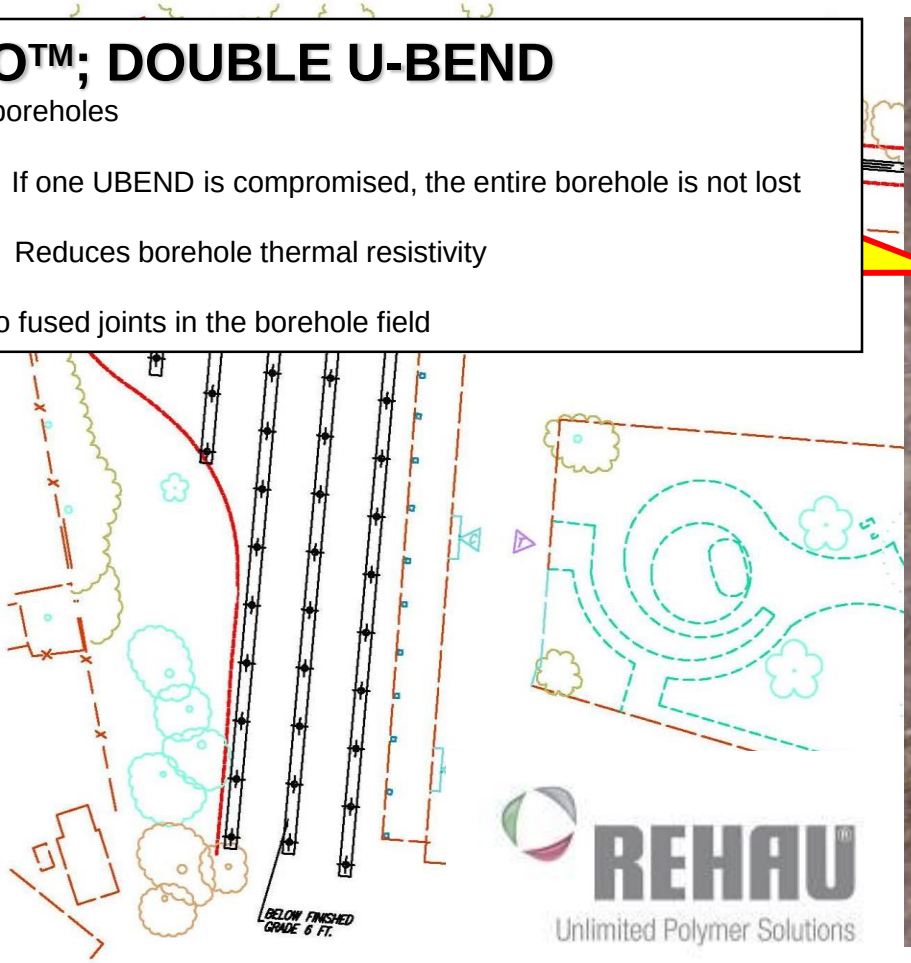
Minnie Howard School, Alexandria

GEOTHERMAL FIELD
- 65 Wells
- 310 ft. deep

RECOMMENDED SOLUTION: GEO-SOLAR SYSTEM

RAUGEO™; DOUBLE U-BEND

- **Cost**: Fewer boreholes
- **Redundancy**: If one UBEND is compromised, the entire borehole is not lost
- **Performance**: Reduces borehole thermal resistivity
- **Reliability**: No fused joints in the borehole field



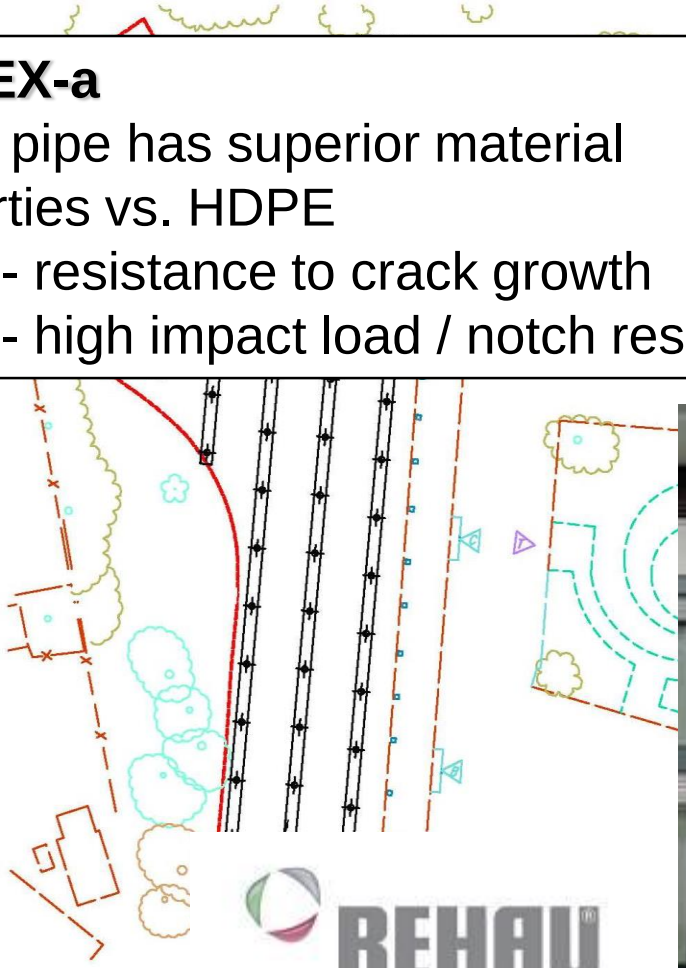
REHAU
Unlimited Polymer Solutions

Minnie Howard School, Alexandria

GEOTHERMAL FIELD
- 65 Wells
- 310 ft deep

RECOMMENDED SOLUTION: GEO-SOLAR SYSTEM

PIPE PEX-a
- PEX-a pipe has superior material properties vs. HDPE
  - resistance to crack growth
  - high impact load / notch resistance



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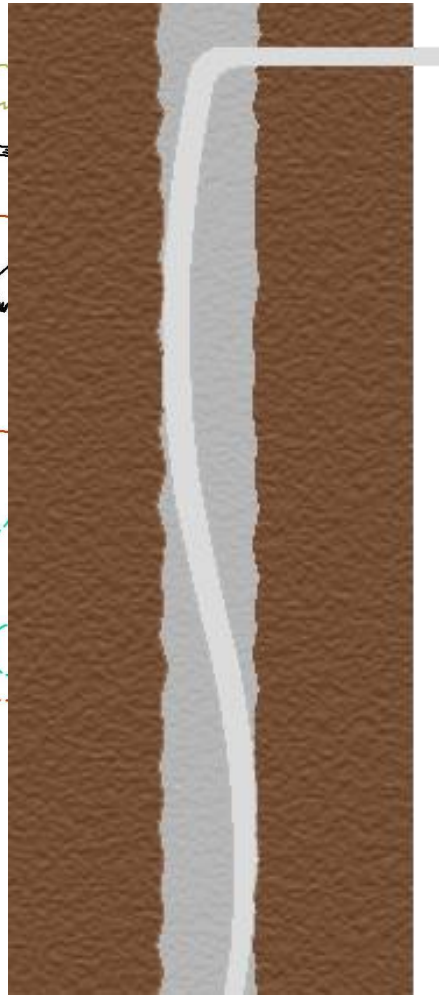
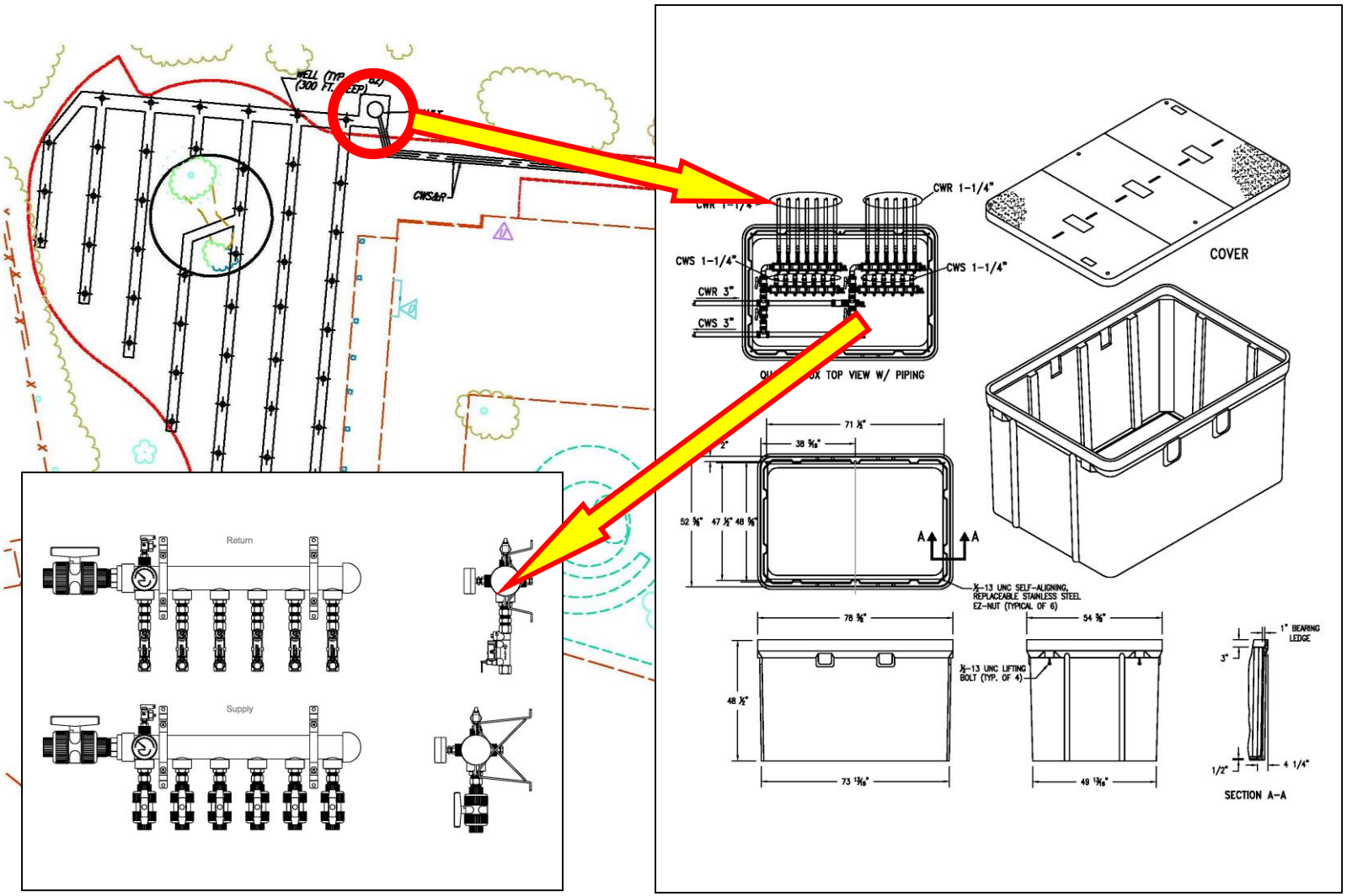


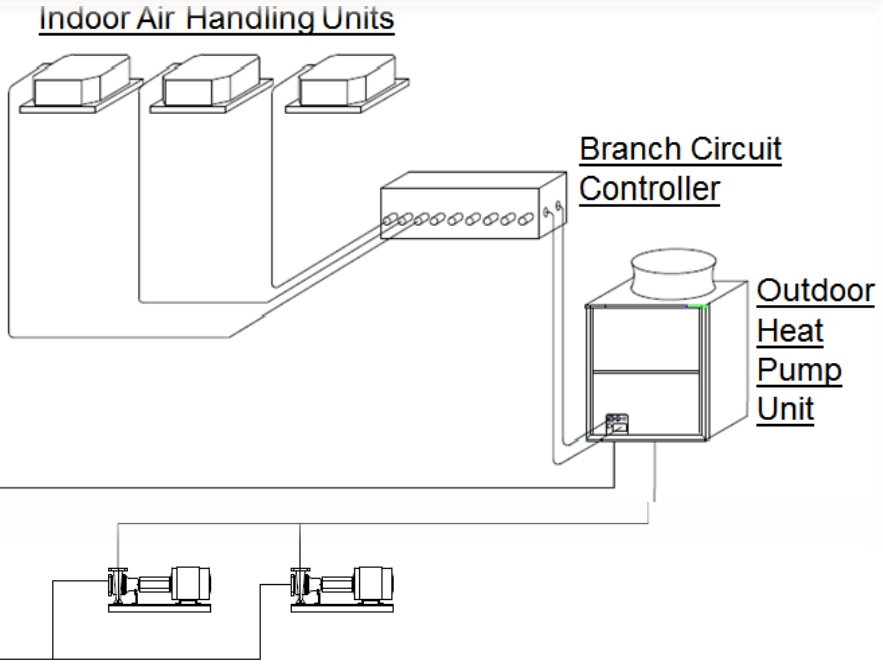
RECOMMENDED SOLUTION: GEO-SOLAR SYSTEM

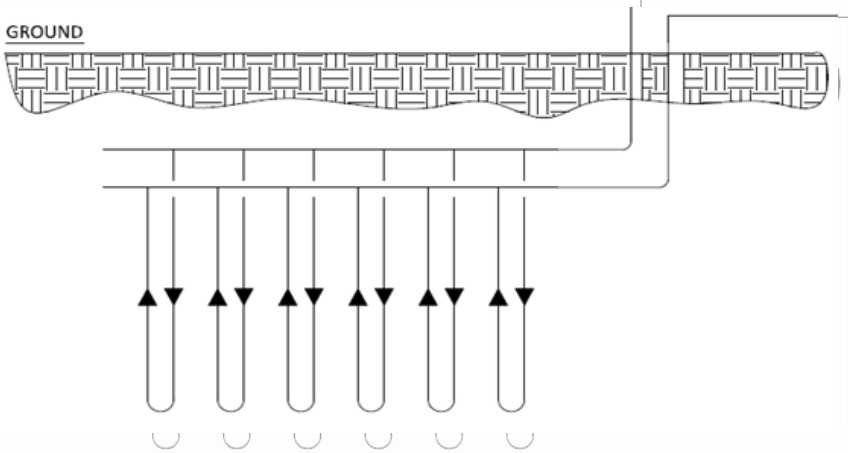


VRF Heat Pump System with Geothermal

Variable Refrigerant Flow Heat Pump System

Geothermal Well Field





- Constant temperature of the earth provides heating or cooling
  - In summer, heat is rejected into the ground
  - In winter, heat is extracted from the earth

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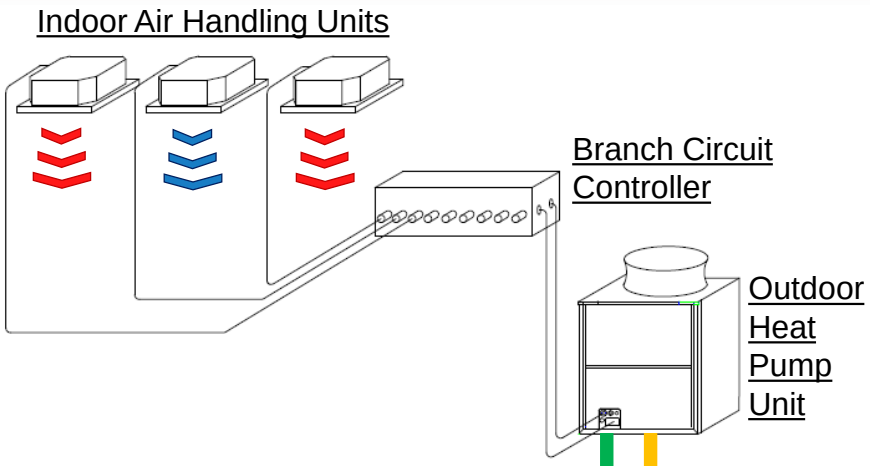
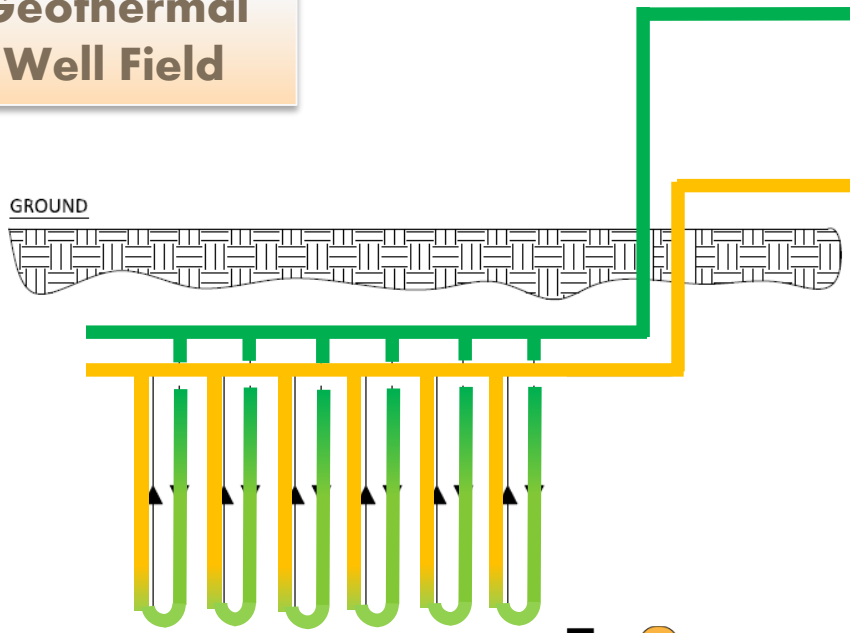
VRF Heat Pump System with Geothermal

Variable Refrigerant Flow Heat Pump System



Geothermal Well Field



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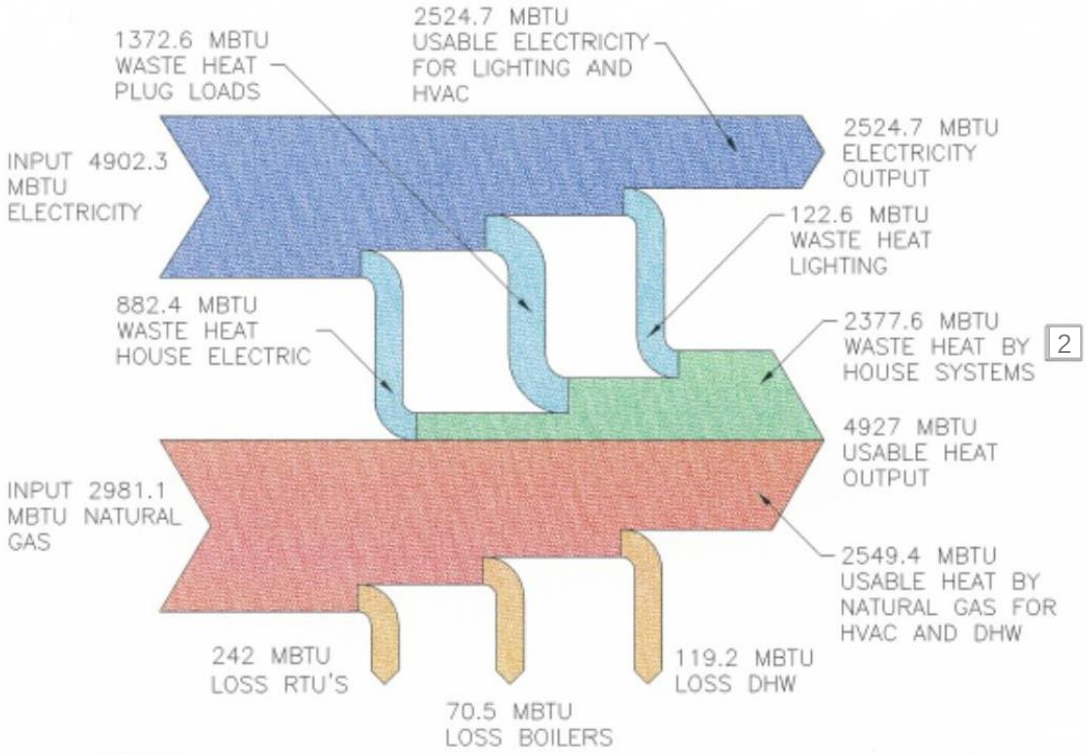
BASE CASE HEATING ENERGY FLOW DIAGRAM (58.83 KBTU/SF YEAR) [1]



NOTES:

1. ENERGY FLOW DIAGRAM FOR HEATING; COOLING IS SIMILAR.
2. REPRESENTS HEAT GAIN IN WINTER; INTERNAL LIGHTS AND EQUIPMENT COOLING LOAD IN SUMMER.

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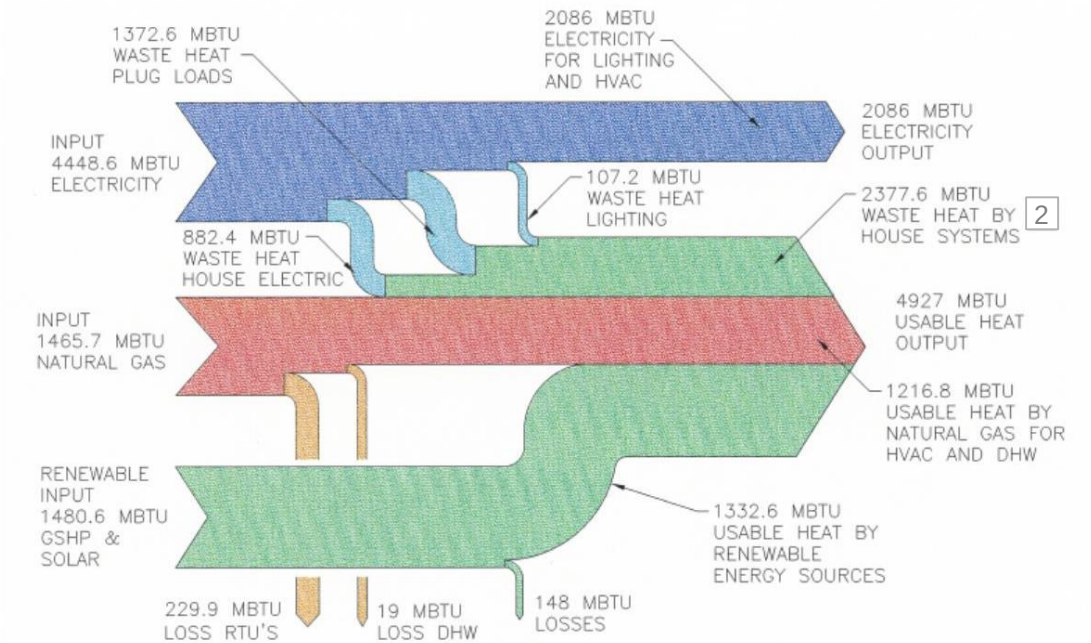
GEO-SOLAR HEATING ENERGY FLOW DIAGRAM (44.14 KBTU/SF YEAR) [1]



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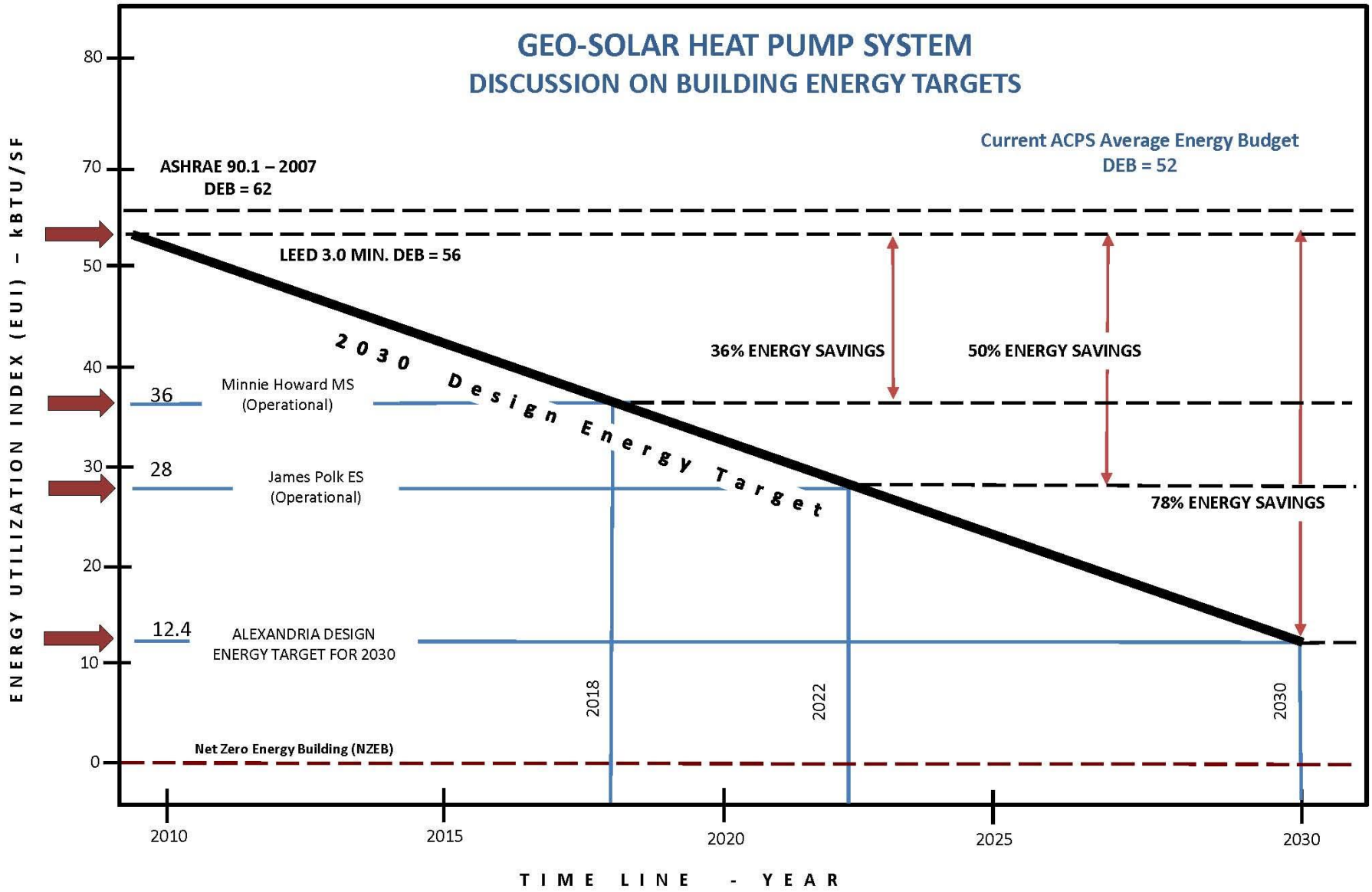

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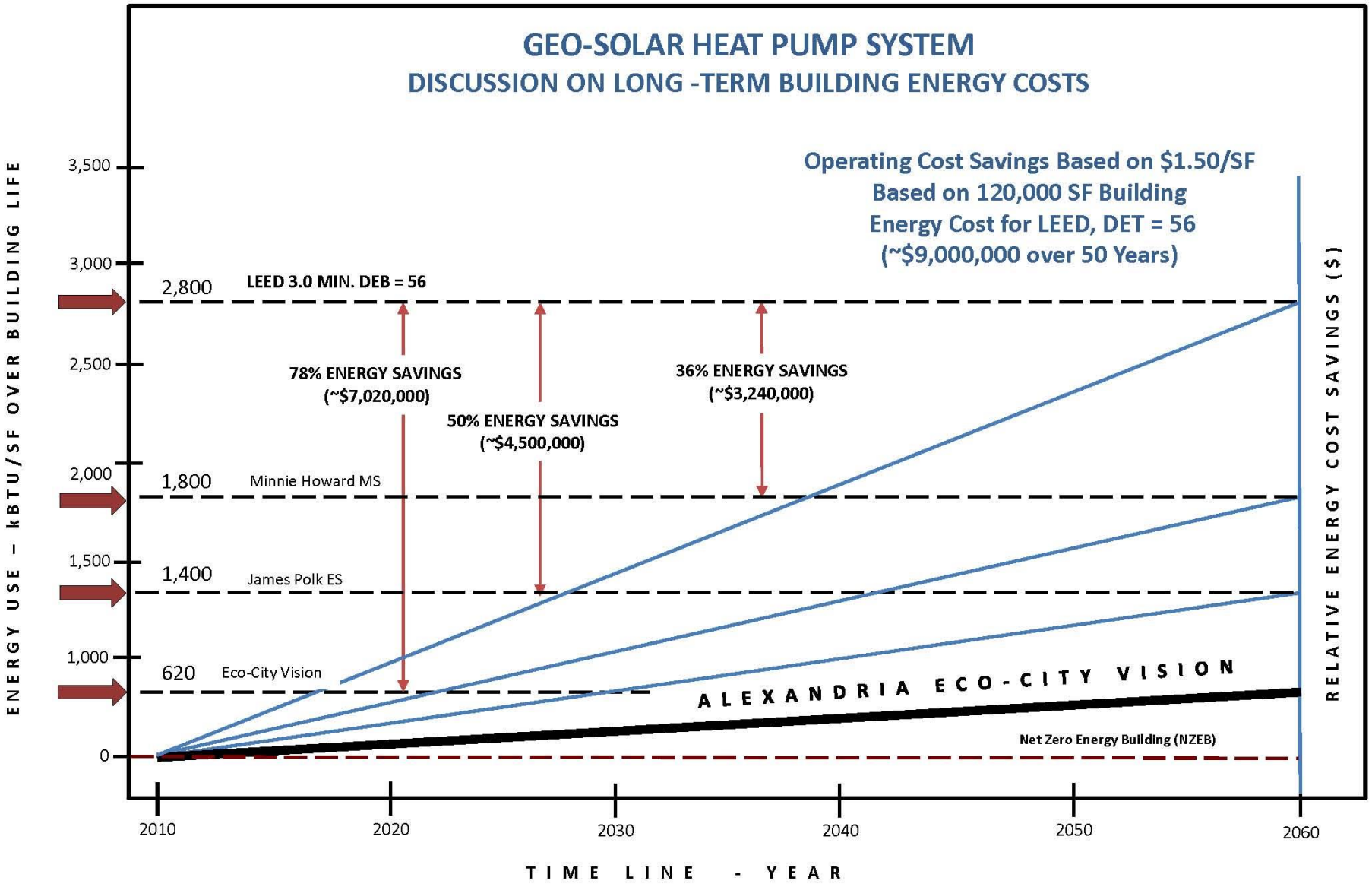

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GEOTHERMAL PROJECTS IN LOUDOUN COUNTY

Existing:

Brambleton Fire Station (34 tons)
Lucketts Community Center (36.5 tons)
Bluemont Community Center (28 tons)
Fire Station #26 (20 tons)
Transportation Maintenance Operations Facility (16 tons)
Youth Shelter (29.5 tons)

In Construction:

Ashburn Safety Center
Kirkpatrick Fire Station

In Design:

Jr Detention Center
Lucketts Fire Station
Sterling Community Center
Sterling Rec Center
Lovettsville Community Center

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COMPARISON: 4-PIPE vs GEO-SOLAR SYSTEM (66,000 SF)

Building Heating and Cooling Systems	INPUT (MBTU)		INPUT ($)	
HVAC SYSTEM	**GAS**	**ELECTRICITY**	**GAS**	**ELECTRICITY**
CONVENTIONAL (4-Pipe)	**2,343**	**774.8**	**$23,907**	**$18,735**
GEO-SOLAR – HEAT PUMPS	**316**	**462.8**	**$4,266**	**$11,190**
SAVINGS	**2,027**	**312**	**$19,641 (82%)**	**$7,545 (40%)**

***Note**: Table shows energy use of HVAC system only. It does not include packaged rooftop HVAC units. Does not include Lights Computers & Plug loads or House Systems Energy Usage*

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SUMMARY

GEO-SOLAR GROUND-SOURCE HEAT PUMP SYSTEM

- Energy Savings is ~54,600 Mbtu (or 16 Million kWh) over 20 years
- Simple Payback~5 years.
- Discounted Payback ~12 years.
- Lifetime From Well Field is 50+ years
- Energy Cost Savings of ~640,000 over 20 years (in PV 2008 Dollars)
- Life cycle COST SAVING ~$406,000 over 20 years (in PV 2008 Dollars)
- Reduction of Greenhouse Gases 124,800 kg CO_2, 415 kg SO_2, and 245 kg No_x per year

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THANK YOU FOR LISTENING

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