Sound

Geothermal Corporation

GEOEXCHANGE™

Comfort from the ground up

3962 Alpine Valley Circle
Sandy, Utah 84092

Utah Geothermal Working Group

Low Temperature Geothermal

April 22, 2008

GeoExchange[SM]: Applications for Low Temperature Geothermal

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Agenda

-General GSHP Principals
-Benefits of GSHP
-Successful Implementations
-Questions/Discussions

Sound

Geothermal Corp.

Comfort from the ground up

3962 E. Alpine Valley Circle, Sandy UT 84092

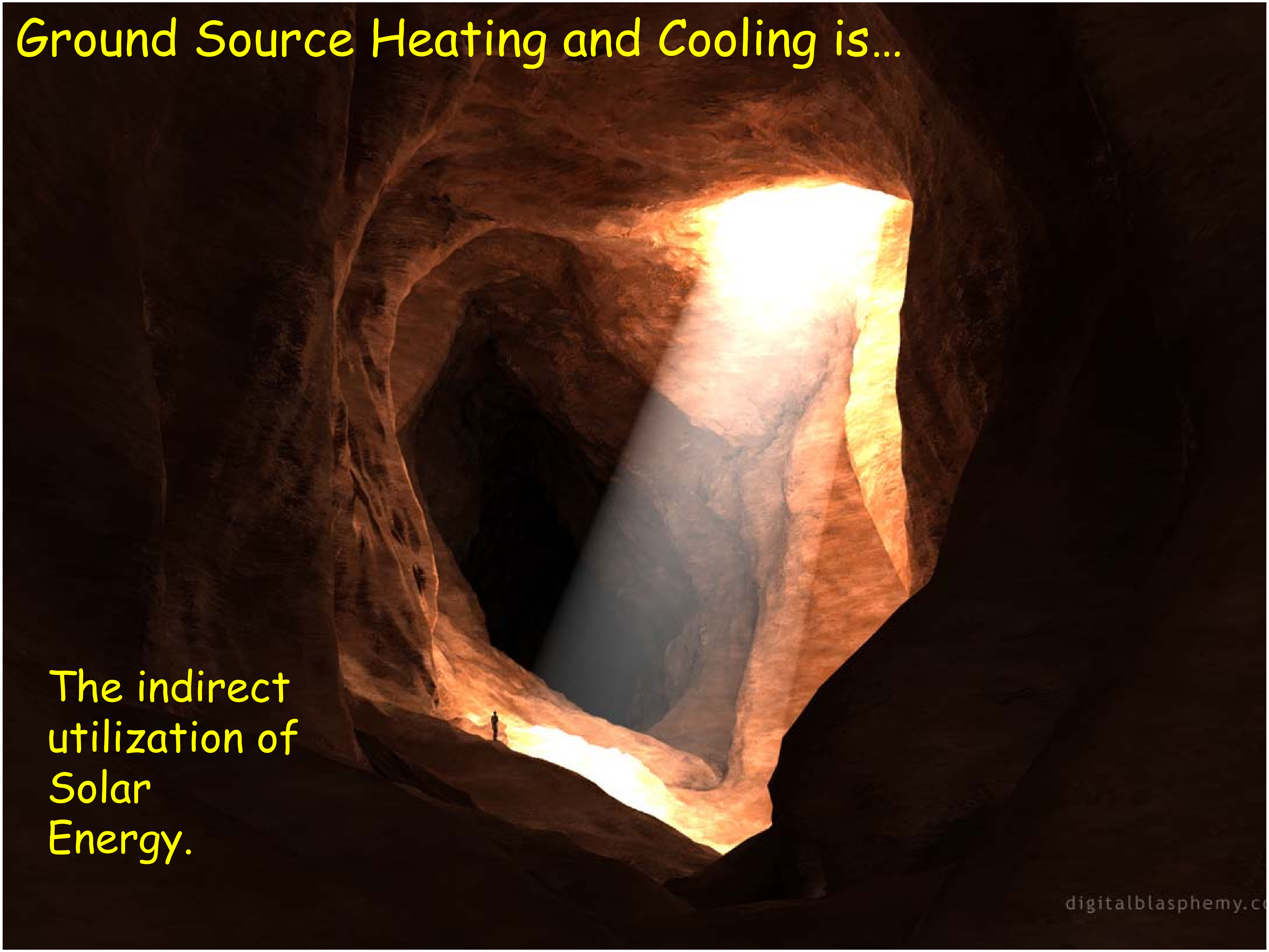
Ground Source Heat Pumps

GX

Geothermal Heat pumps

Ground Coupled Heat Pumps

Earth Coupled Heat Exchanger

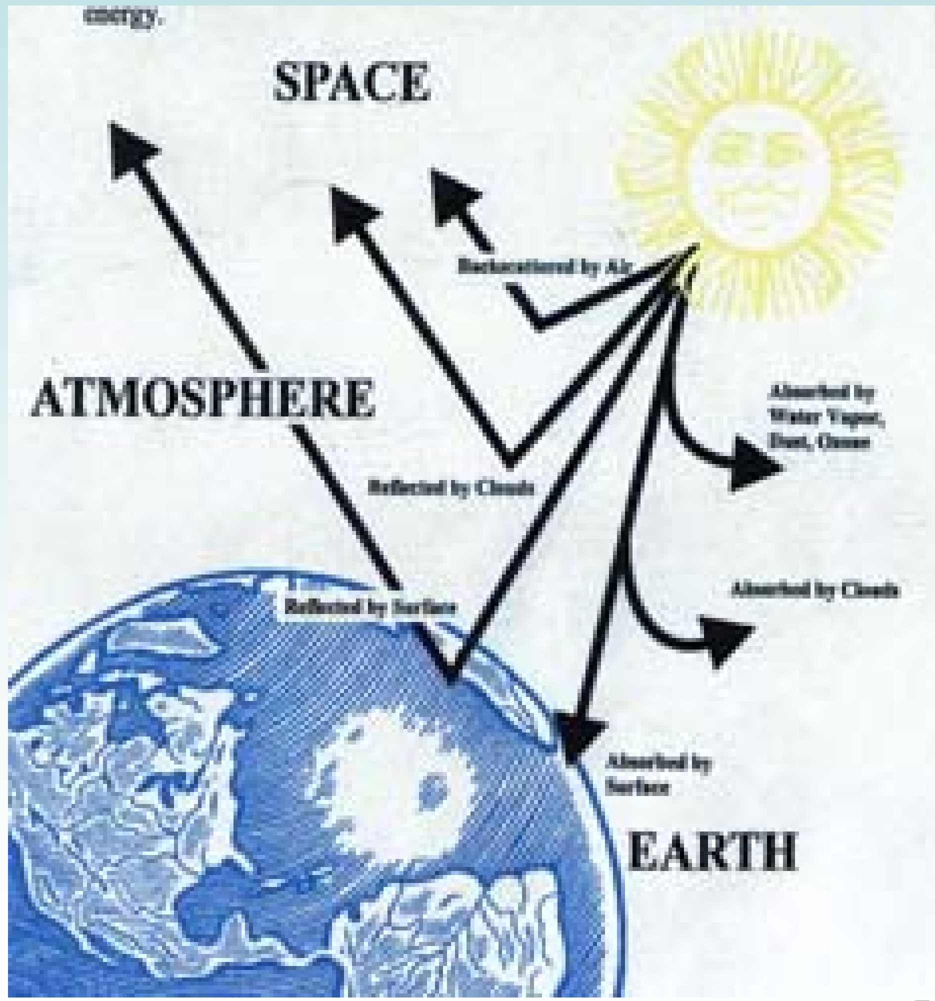

Ground Source Heating and Cooling is…
The indirect utilization of Solar Energy.

Earth stores solar energy…

-Much reflected back by clouds & water

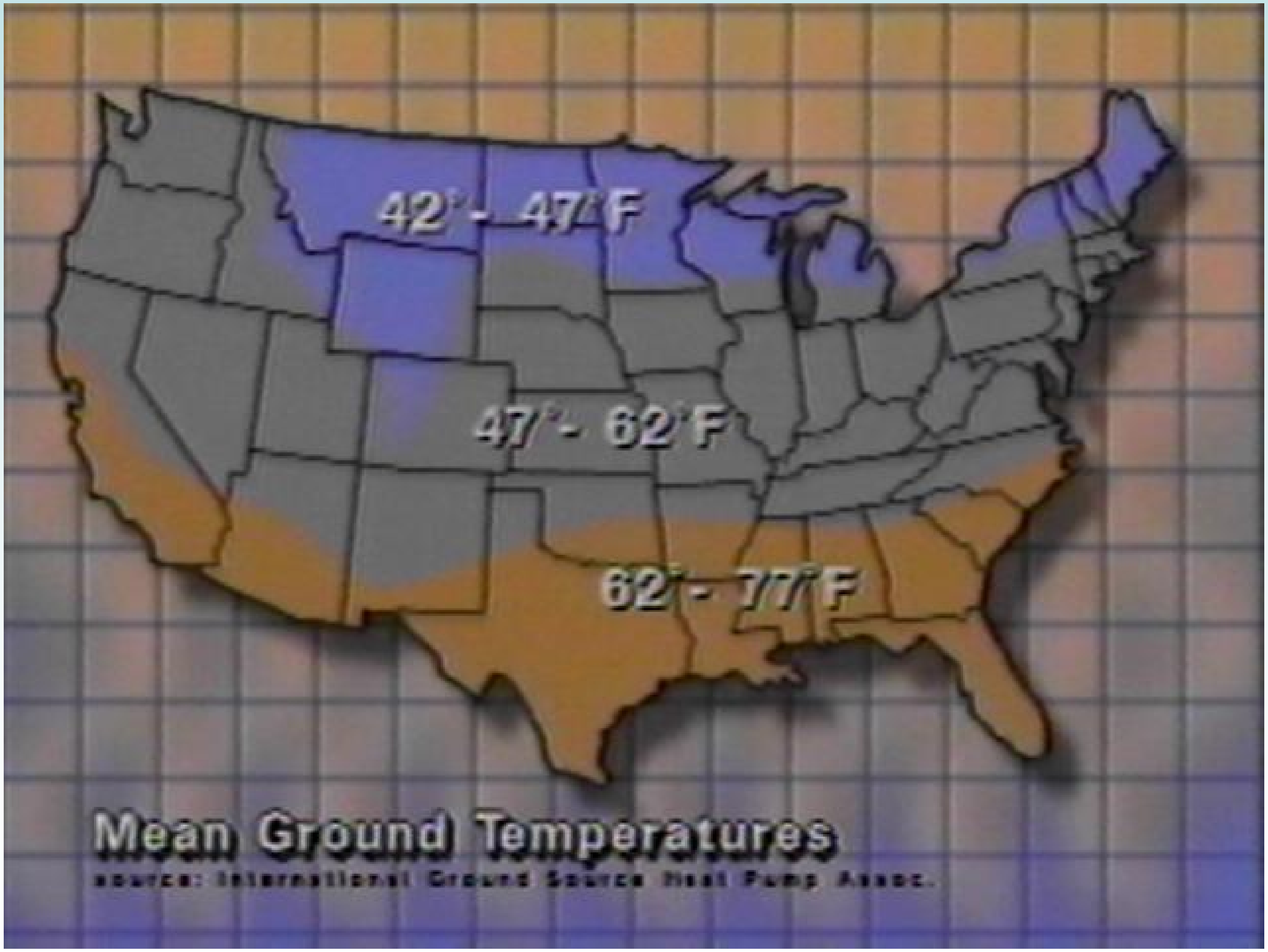
-Some absorbed by atmosphere

-47% absorbed by earth



Relatively Constant Earth Temp

Earth Temps Are Predictable



Big Mass…

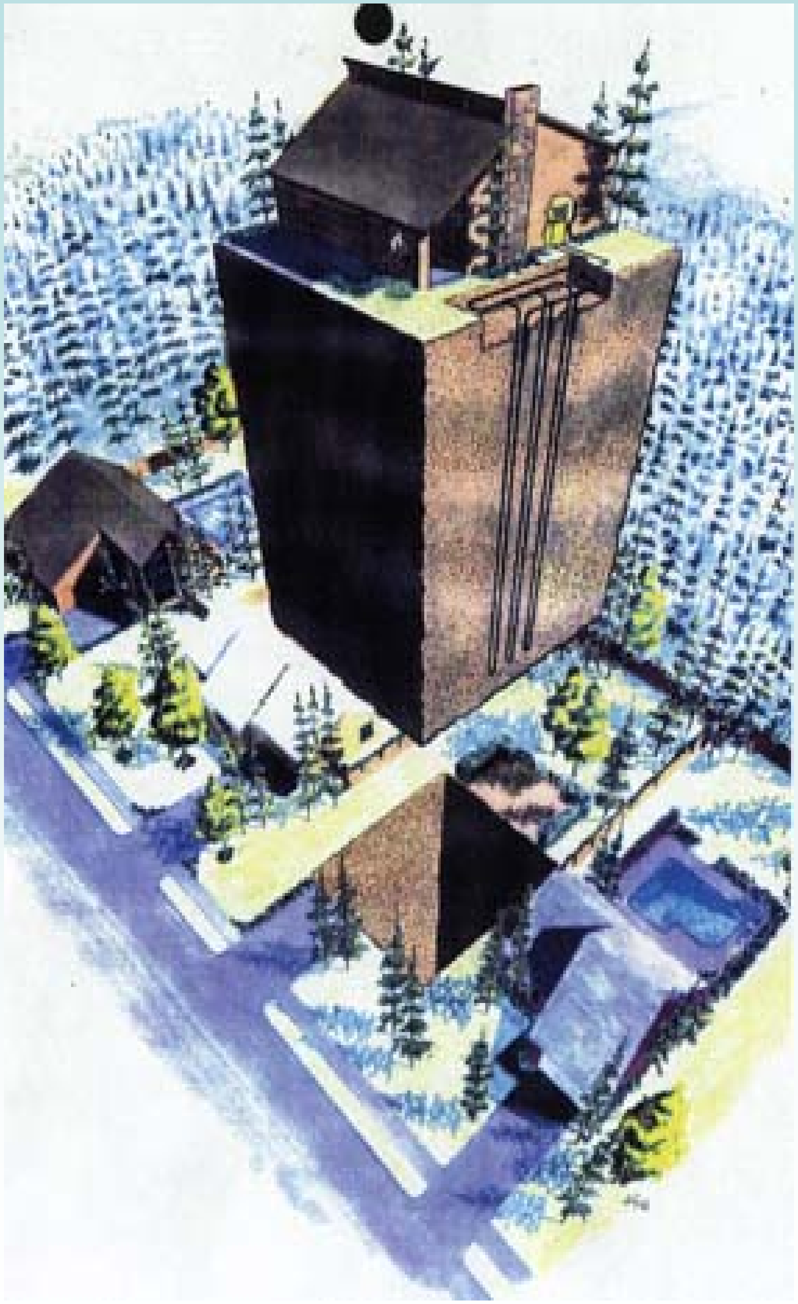
Low Temperature
High Storage Potential

For Example:

Typical Home Site

-400 ft down x lot size

-Enough energy storage for 15 homes



How do we take advantage of this free energy source?

GX Heat Pump Systems

How do heat pumps work?

Heat & cool buildings using the natural heat-storing ability of the earth.

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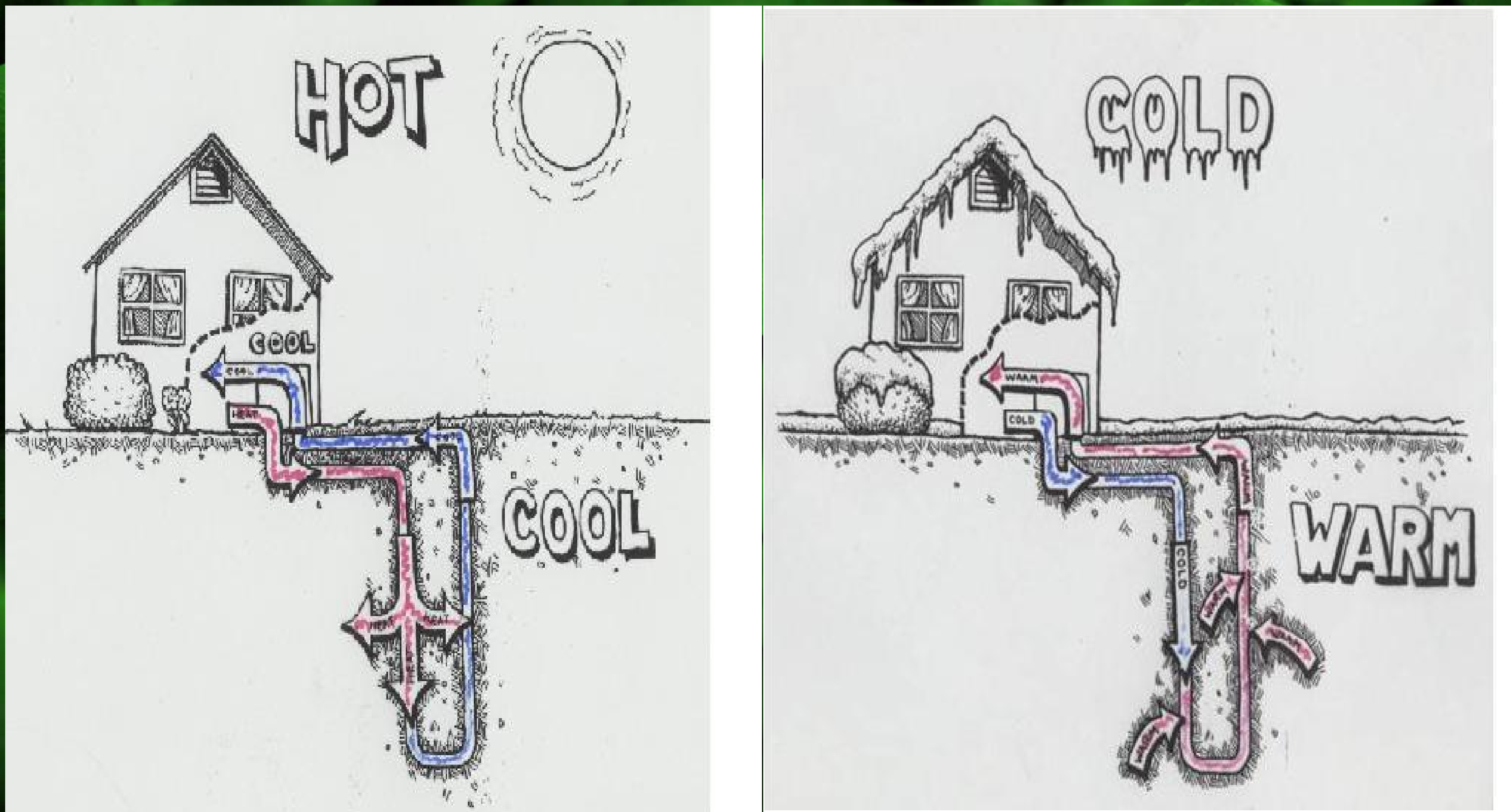
Ground Source Heating and Cooling…

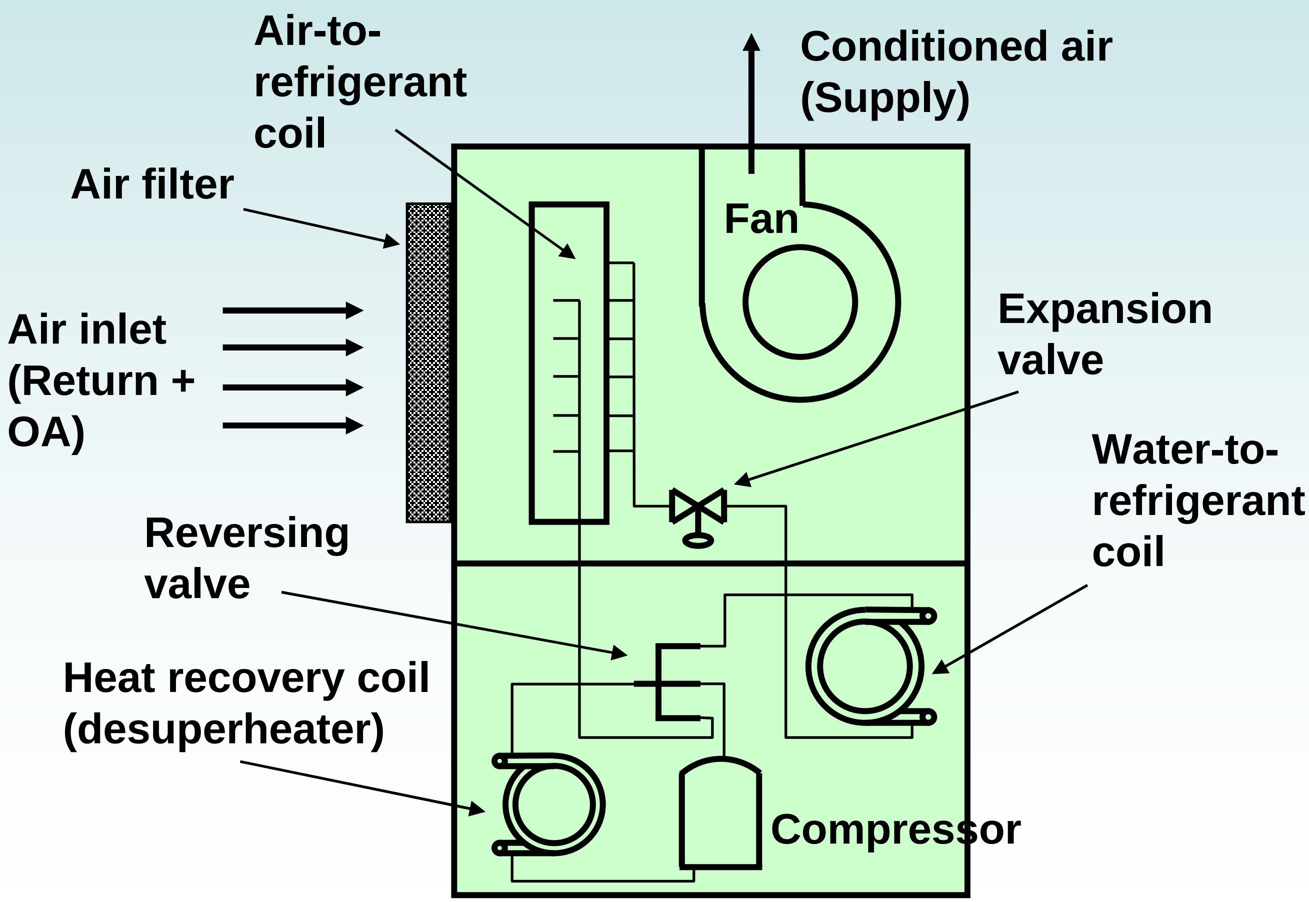


Uses a Heat Pump to move energy from a space into the ground or, energy from the ground into a space.

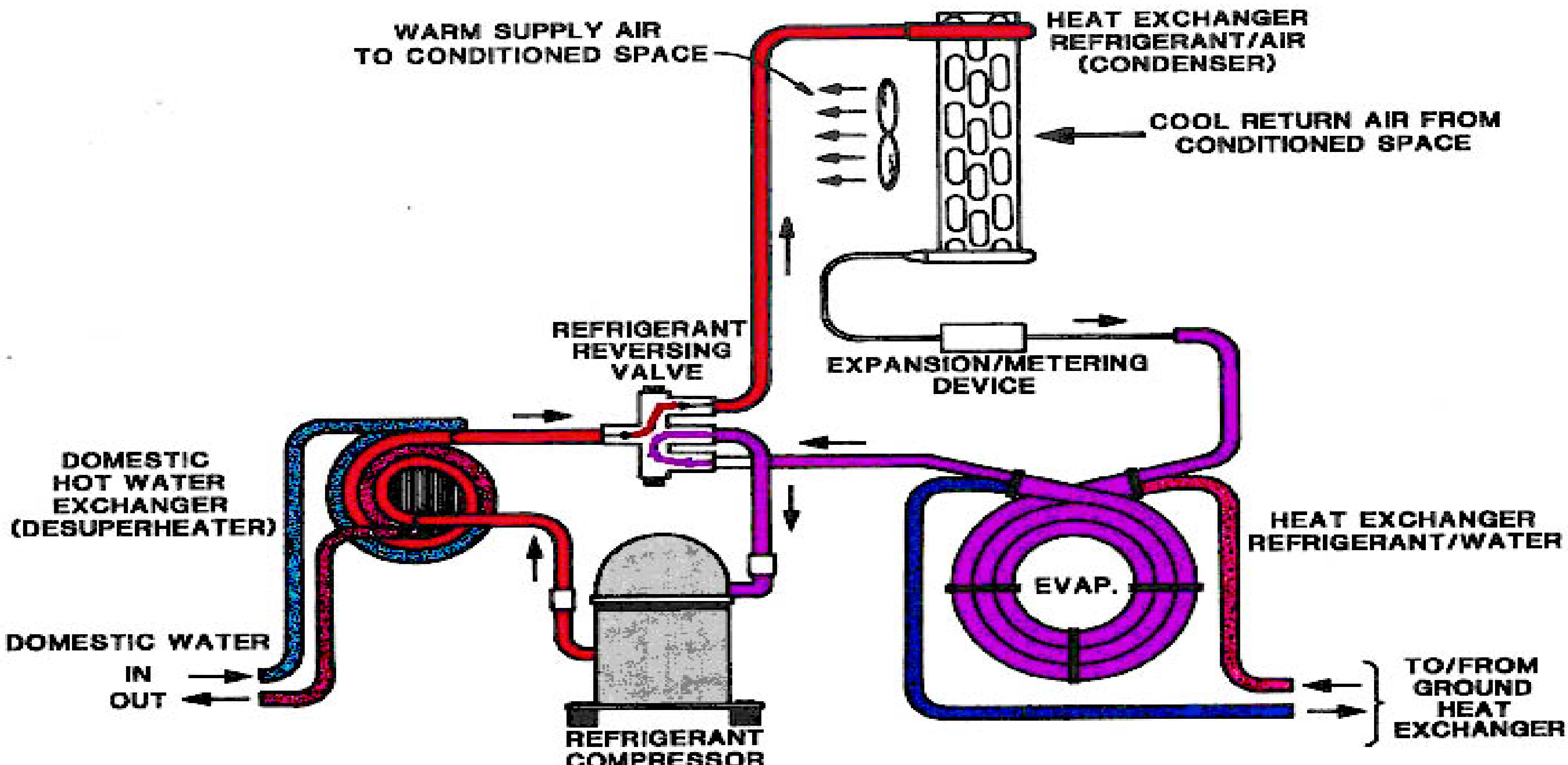
Why GHPs are more efficient than other HVAC equipment?

- GHPs exchange heat with the earth, rather than with ambient air
- Earth provides a much better heat exchange medium
  - Stable year-round temperature
  - Generally cooler than ambient air when cooling is needed, and warmer than ambient air when heating is needed
- Water is a better heat transfer medium than air
  - They use a small amount of energy to move a greater amount of energy.

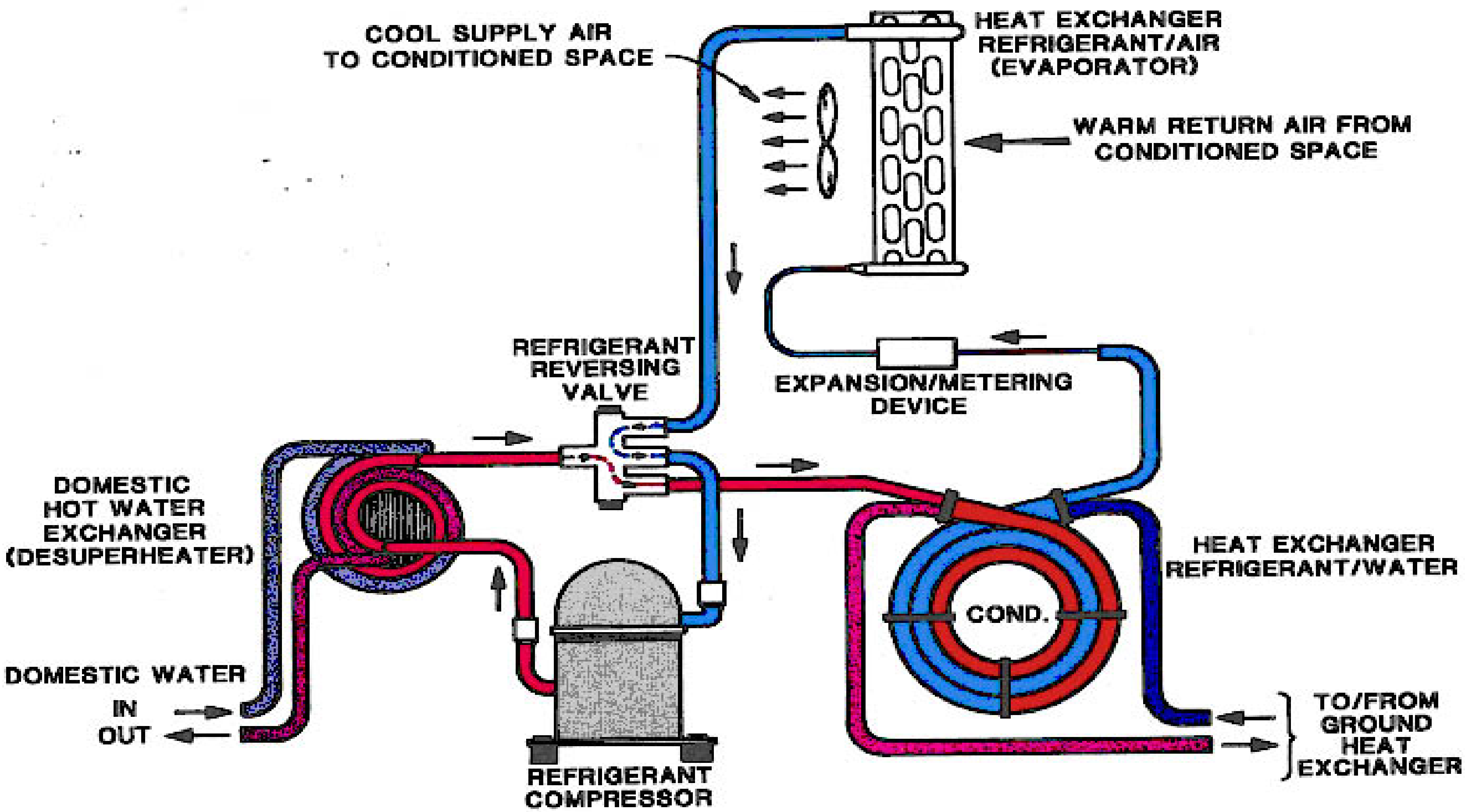
Typical Geothermal Heat Pump



GSHP Operation: Heating Mode



GSHP Operation: Cooling Mode



Cooling Operation

SAMPLE EFFICIENCIES

Propane/Natural Gas –

80% - 95% (COP .85 - .95)

Electricity –

100% (COP 1.0)

Air Source HP –

220% - 280% (COP 2.2 – 2.8)

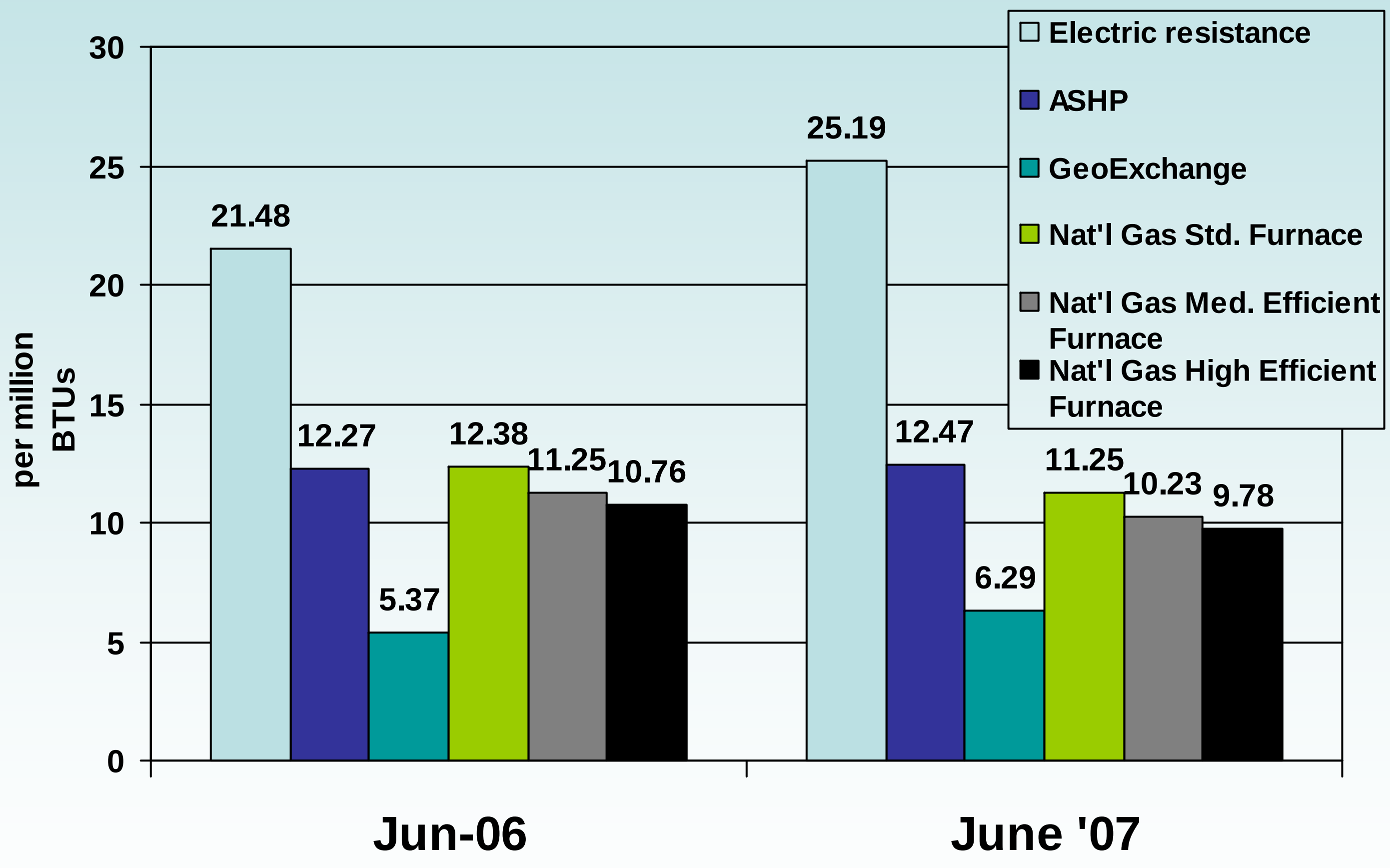
GSHP –

320% - 400% (COP 3.2 – 6.0)

(Cooling) EER 12.0 – 28

SEER 15 – 35

Fuel Cost Comparison



GeoExchange and the Environment

Better Efficiencies – Reduced fuel consumption

Lower Carbon Footprint

Lower Local and Cumulative (Plant) Emissions

No local CO_2 or NO_x emissions.

No gas or oil consumed on site.

For example…

A conventional 4000 ft^2 home in Salt Lake County would produce;

1. An average of $224/month in utility costs.
2. 15,856.7 Lbs of CO_2/yr, Heating (generated onsite).
3. 4,547.4 Lbs of CO_2/yr, Cooling (at coal plant).

As opposed to a GX Heat Pump…

1. An average of $99/month in utility costs.
2. 5,460.3 Lbs of CO_2/yr, Heating (at coal plant).
3. 2,569.2 Lbs of CO_2/yr, Cooling (at coal plant).

Emissions data provided by the Department of Energy.

A perspective for the future…

In 10-years this Ground Source home…

Will have released 62-tons less CO_2 than a typical home.

Will have saved the home owner more than $15,000 in energy costs.

In 25-years…

Greater independence from fossil fuels.

Increased home value.

For a community…

If 500 homes in Utah utilized ground source…

4.2 Million less Lbs. of CO_2 would be produced each year. (A 53.1% greenhouse gas reduction over a conventional home.)

That equates to…

~234 Jeep Cherokees or 300 mid-sized autos .

~2,876 Trees.

~575 Acres of Green Space.

…a higher quality of life.

Some numbers;

For every 300,000 tons of GX …

23-Billion kWh avoided consumption.

18,000 MW avoided winter capacity.

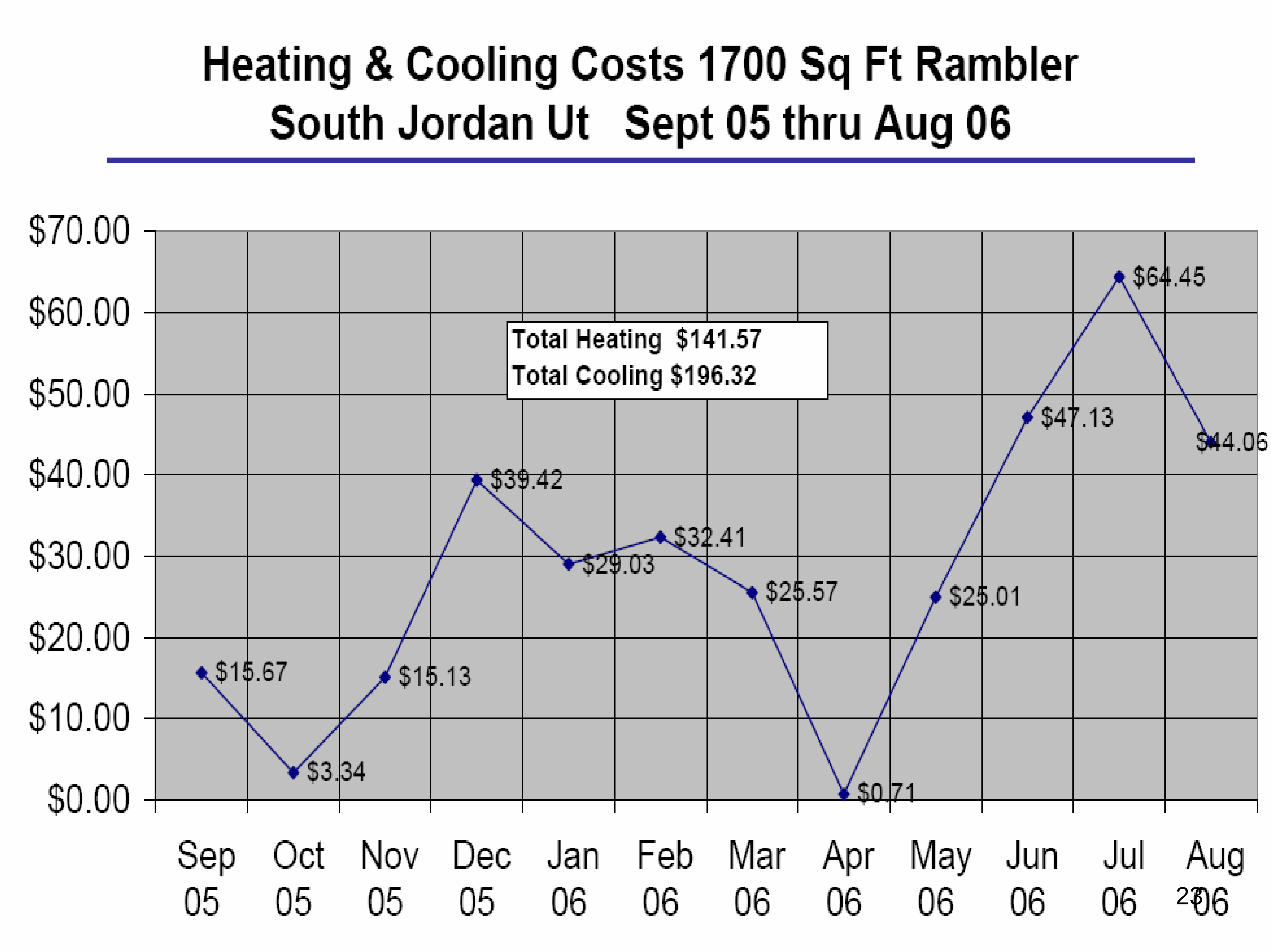
25,000 MW avoided summer capacity.

17.3 million avoided tons of CO_2.

650,000 cars taken off the road.

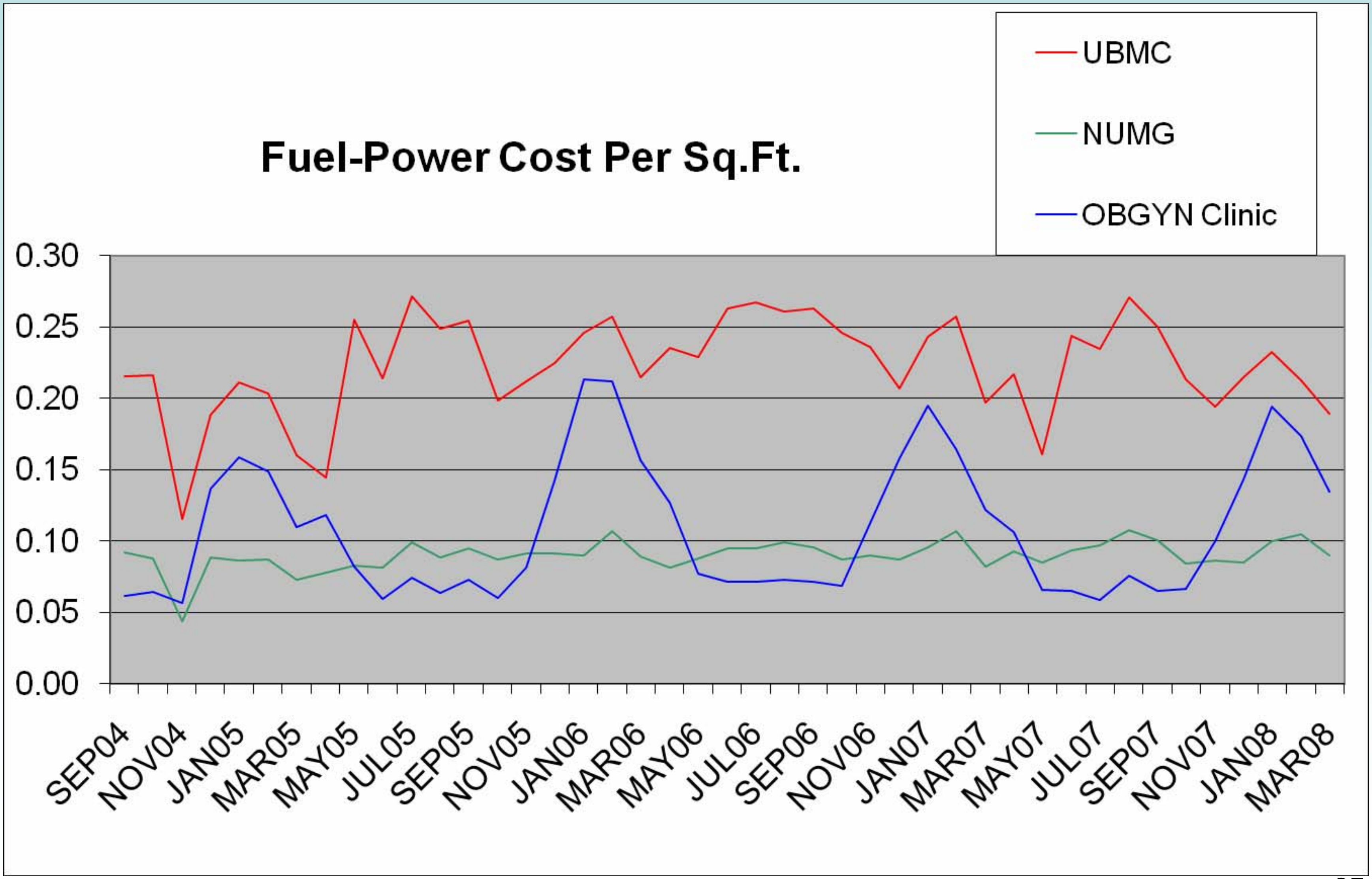
11-million barrels of crude.

Data provided by the E.P.A.

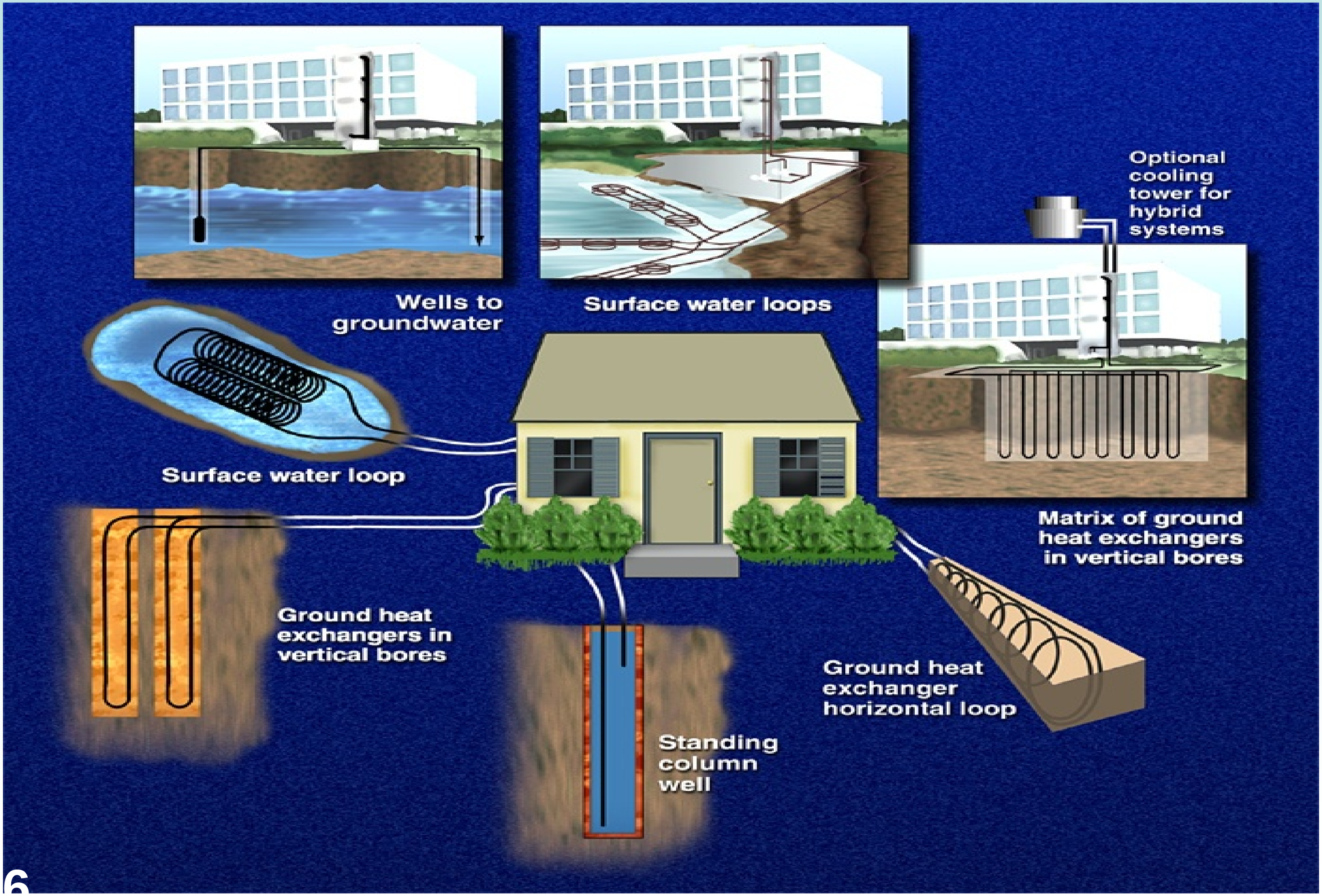

Heating & Cooling Costs 1700 Sq Ft Rambler
South Jordan Ut Sept 05 thru Aug 06
Total Heating $141.57
Total Cooling $196.32
$70.00
$60.00
$50.00
$40.00
$30.00
$20.00
$10.00
$0.00
$15.67
$3.34
$15.13
$39.42
$29.03
$32.41
$25.57
$0.71
$25.01
$47.13
$64.45
$44.06
Sep 05
Oct 05
Nov 05
Dec 05
Jan 06
Feb 06
Mar 06
Apr 06
May 06
Jun 06
Jul 06
Aug 06


Rural Medical Clinic
35,000 sq. ft.
2004 to March 2008 Fuel Cost:
$0.095 ^ft/mo (38% fuel cost reduction)

UINTAH BASIN MEDICAL CLINIC



GHP system options



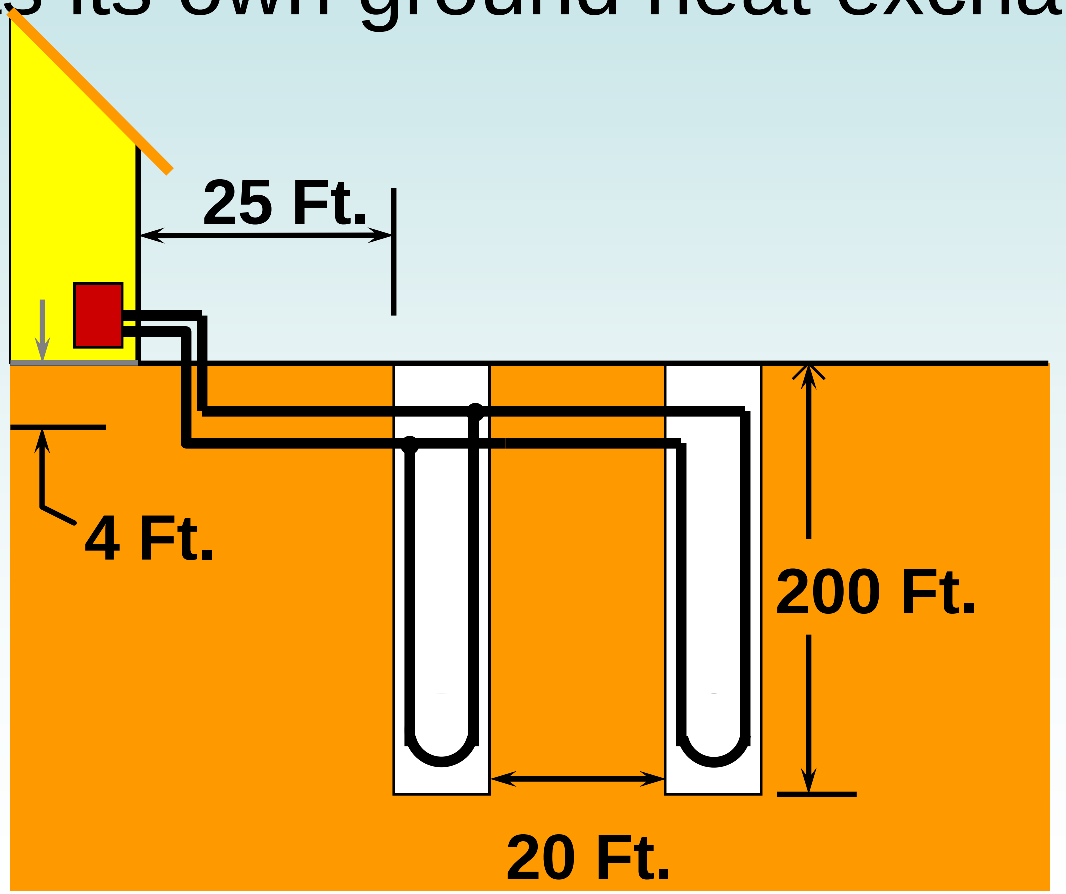
Horizontal Slinky Loop

Horizontal Slinky Loop

Horizontal Slinky Loop

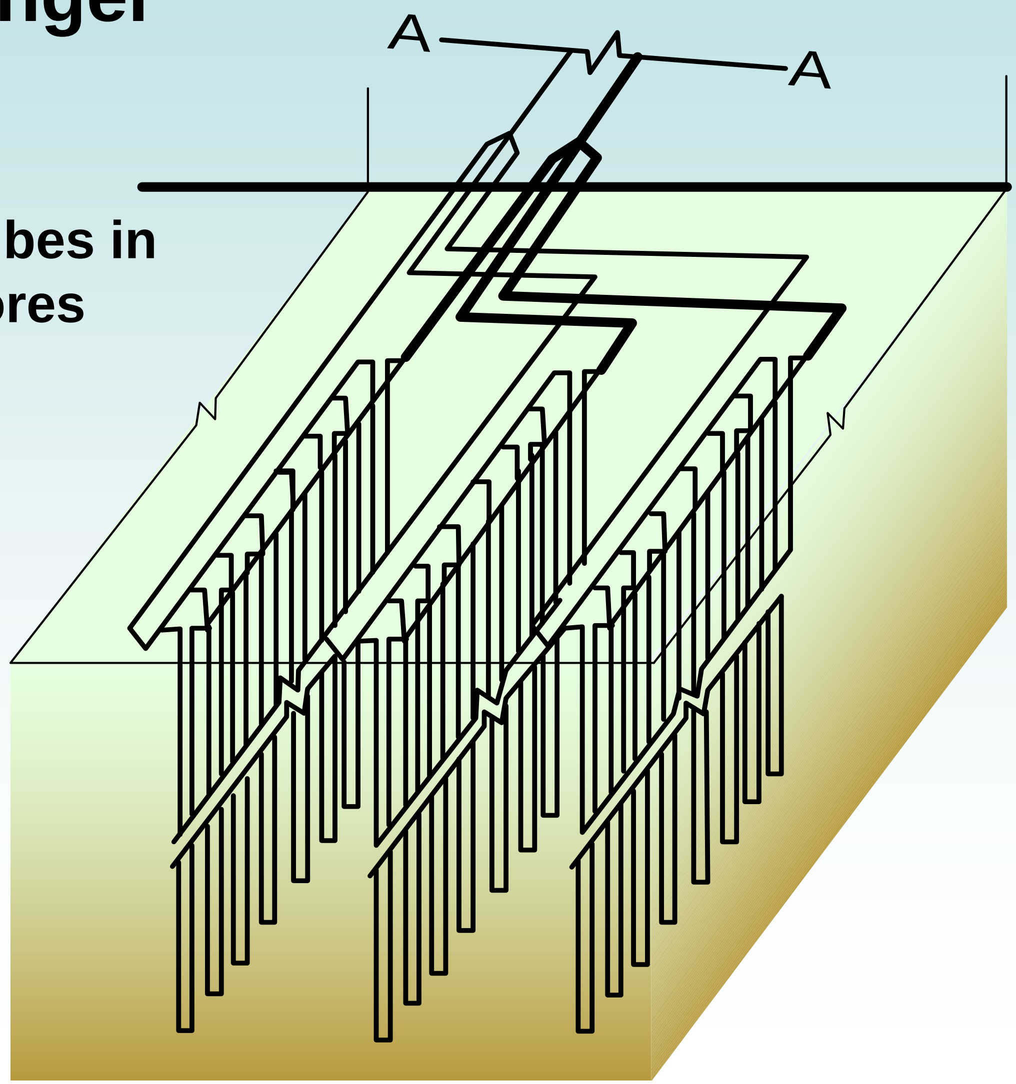
Horizontal Slinky Loop

Residential systems: Each home typically has its own ground heat exchanger



Common loop conditioned by vertical ground heat exchanger

HDPE u-tubes in vertical bores



Generally requires 250-300 ft^2 of land area per ton


2005 12 16

POND / LAKE SYSTEM

POND / LAKE SYSTEM

POND / LAKE SYSTEM

What we need to know about the earth before design of the loop.

- Soil properties – Type of soil
- Earth temperature
- Formation Thermal Conductivity (k - Btu/hr-ft-°F)
  - A measure of a material's ability to conduct heat.
- Formation Thermal Diffusivity (α=k/ρc - ft2/day)
  - Ratio of heat conduction rate to heat storage capacity.
- Excavation or drilling characteristics

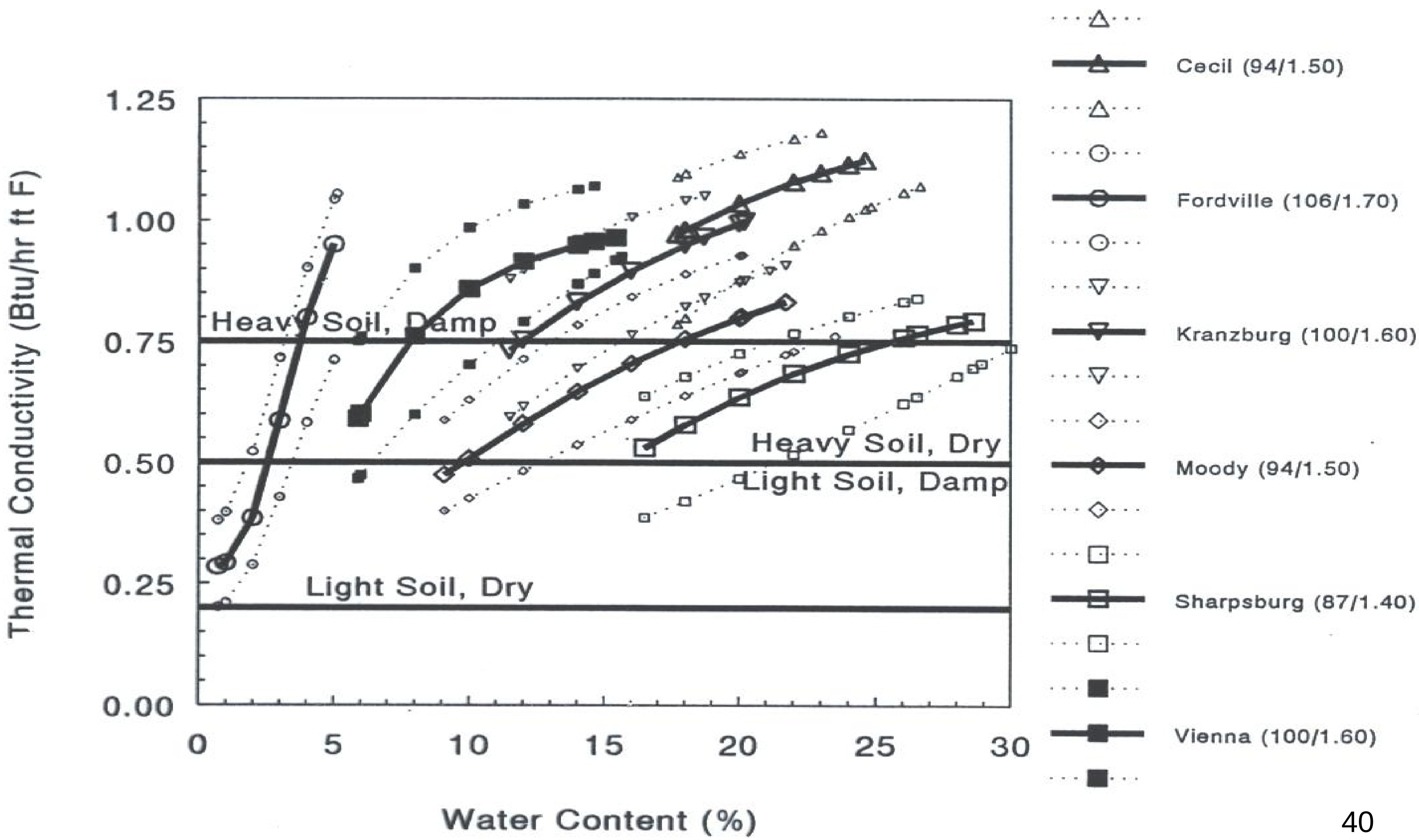
Shallow Loops- Soil Thermal Groups

- Coarse-Grained
  - Water content has large effect
  - Higher values of thermal conductivity if dirty
- Fine-Grained
  - Silt or Clay
  - Silts have higher thermal conductivity values
- Loam
  - Mixture of sand, silt and clay

Soil Thermal Properties

Thermal Texture Class	Thermal Conductivity W/m°K	Btu/ft hr °F	Thermal Diffusivity cm^2/sec	ft^2/day
Sand (or gravel)	.77	0.44	.0045	.42
Silt	1.67	0.96	–	–
Clay	1.11	0.64	.0054	.50
Loam	.91	0.52	.0049	.46
Saturated Sand	2.50	1.44	.0093	.86
Saturated Silt or Clay	1.67	0.96	.0066	.61

Moisture content is very important:



Vertical Boreholes

Most of the GX sites in Utah will fall into one of three hard-rock categories.

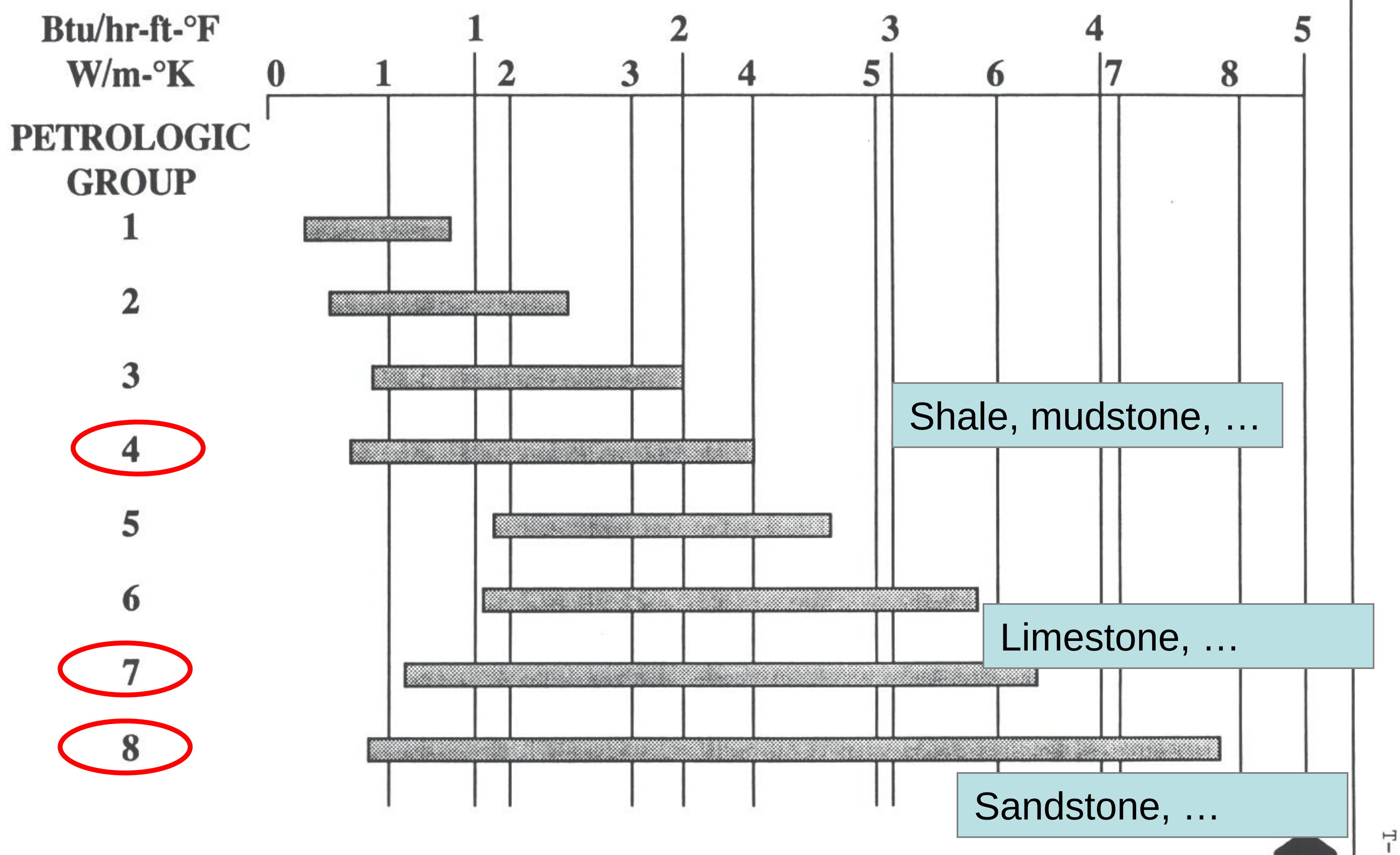
However, thermal conductivity is highly variable.

T-3.5

Petrologic Groups

Petrologic Group Number	Principal Rock Type
1	Pumice, obsidian, perlite
2	Basalts
3	Andesite, rhyolite
4	Mudstones
5	Granite, granodiorite, quartz, monzonite, diorite, diabase, gabbro, peridotite
6	Schist, amphibolite, gneiss, phyllite
7	Limestone, dolomite, marble
8	Sandstone and tuff

Thermal Conductivities of Petrologic Groups



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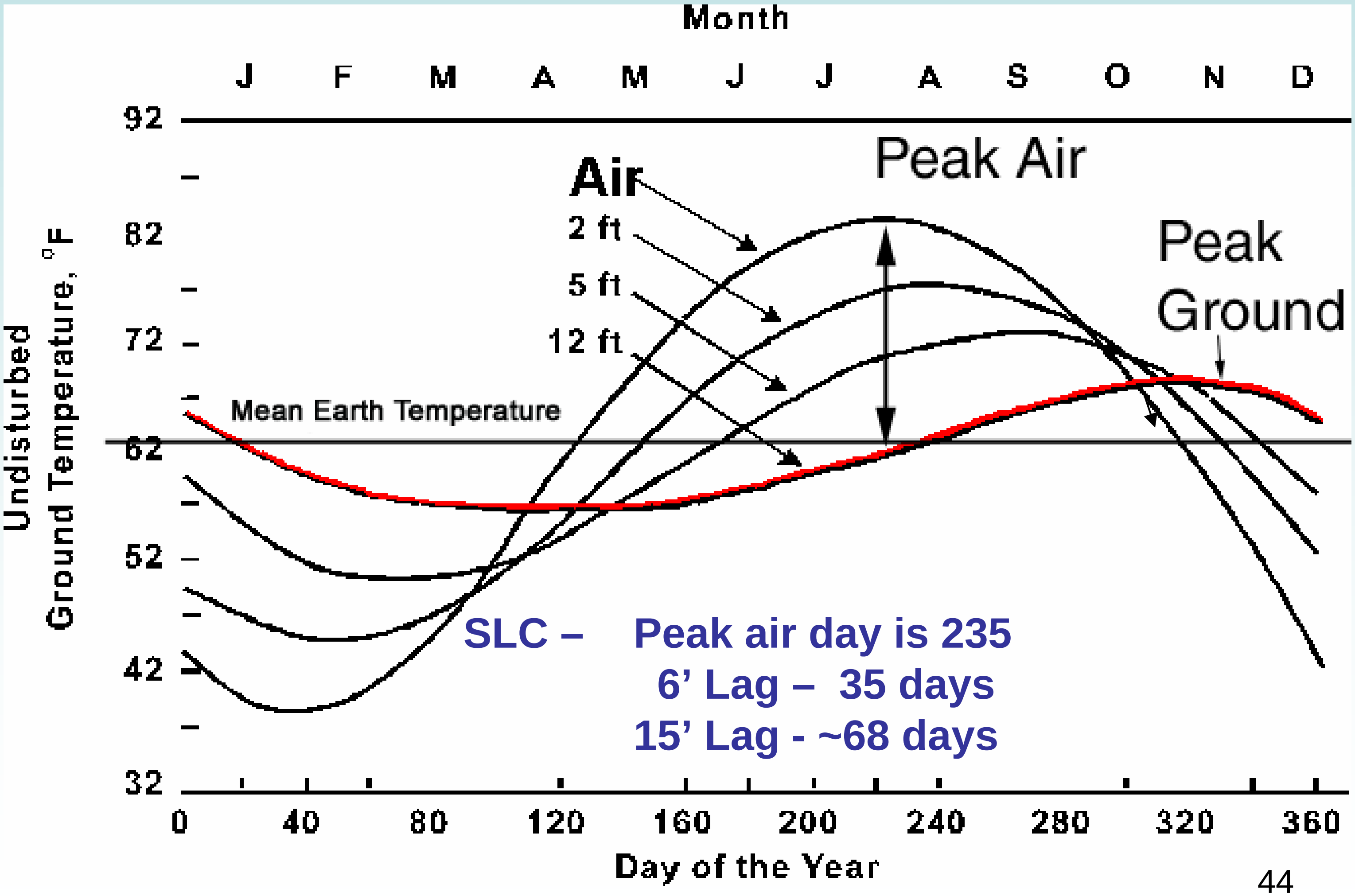
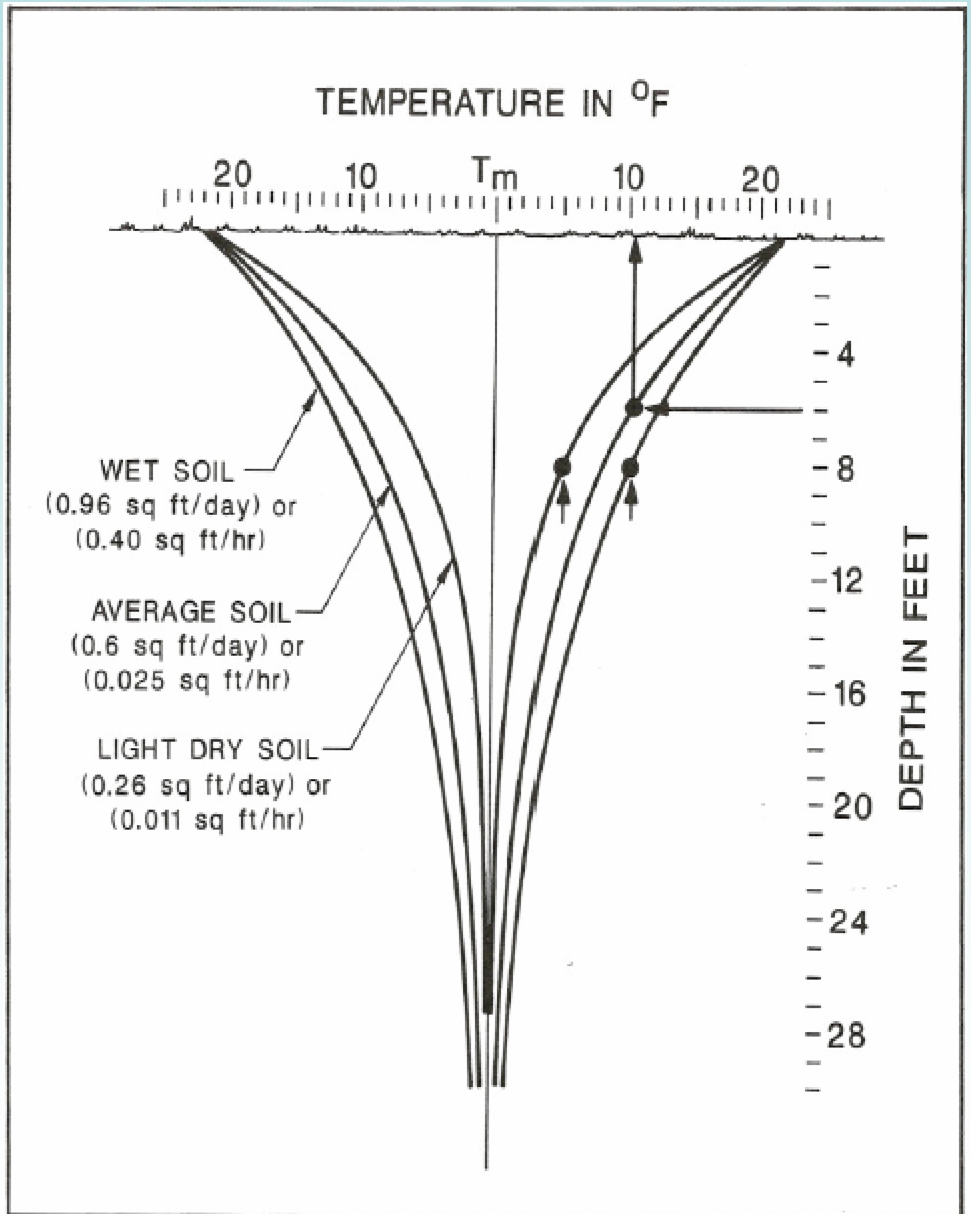
Constant Earth Temperatures Compared to Air



Soil Temperature

- Soil temperature is variable to about 26 feet.
- At ~26 feet the temperature is +/- 2º F of the mean surface air temperature.
- Generally, below ~26' to approximately 1,000', the earth temperature will remain ~constant.
- Geologic anomalies (faults, thermal intrusions, etc.) may change this rule of thumb.



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Formation Thermal Conductivity Testing

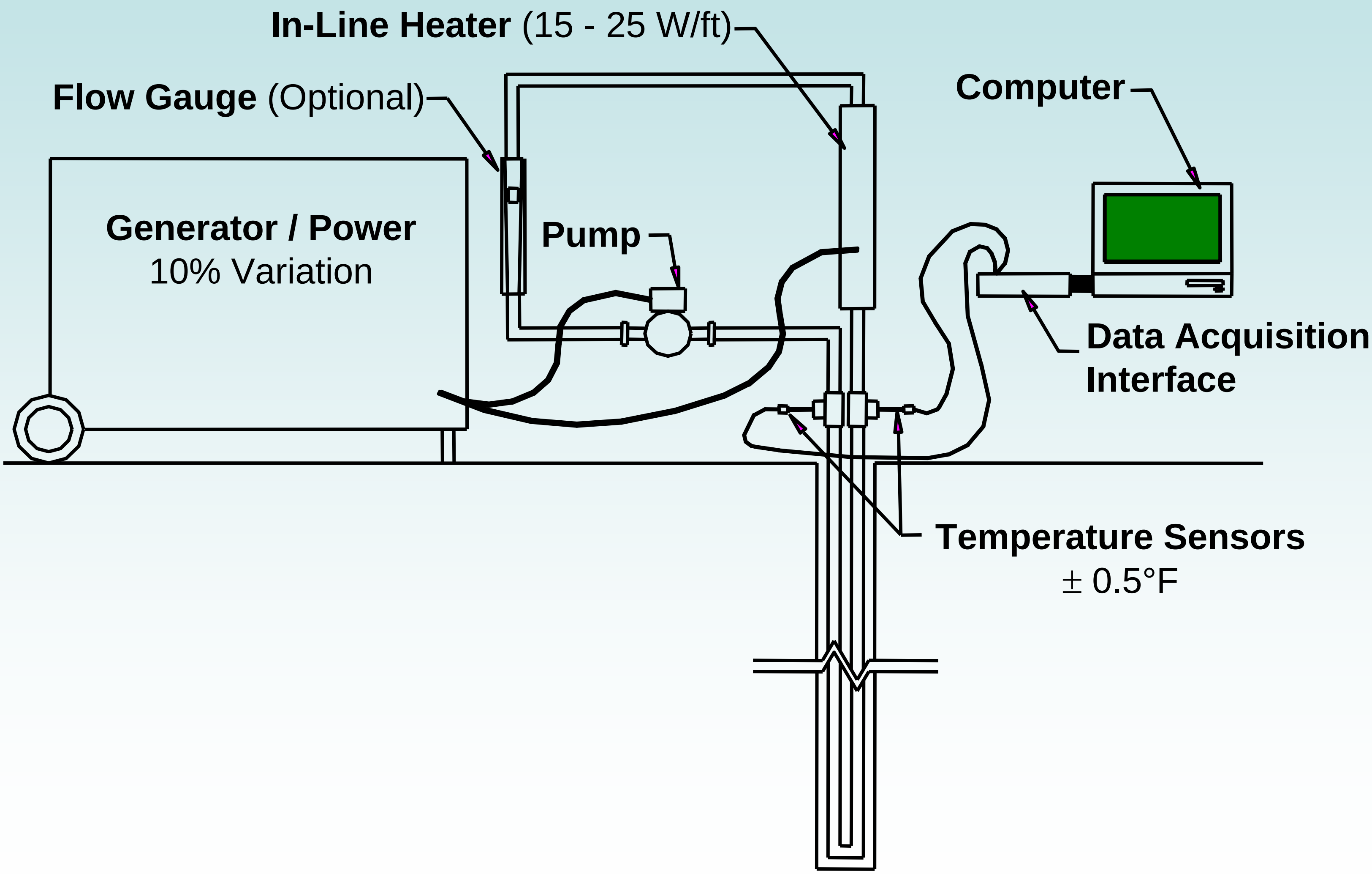
Other than building load distribution, soil (earth) conditions are the largest factor in determining the shortest necessary loop length, either conventional or hybrid.

ASHRAE Recommended Procedures

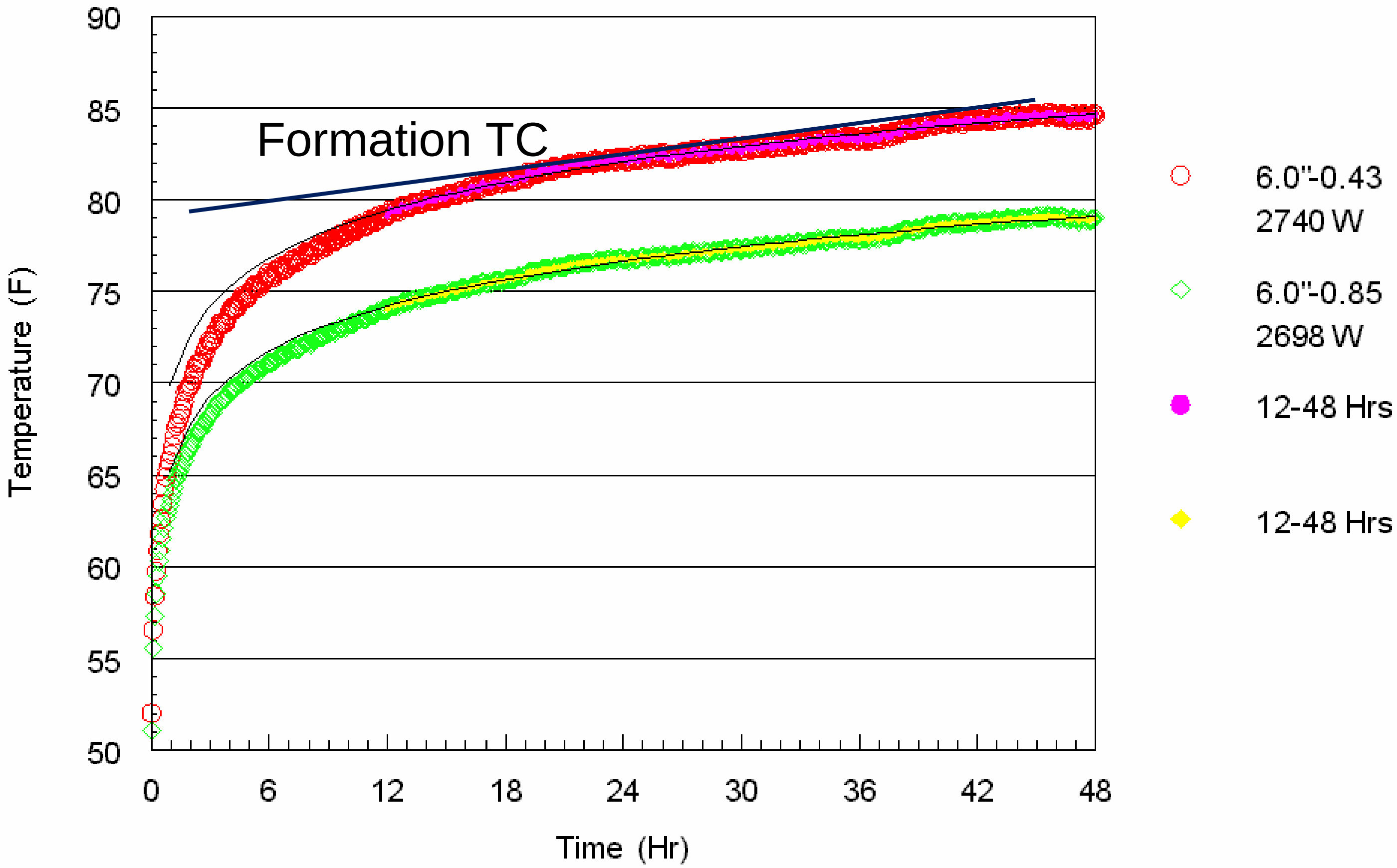
ASHRAE's 2003 HVAC Applications handbook, page 32.14

- **Required Test Duration** – 36 to 48 hours.
- **Power**
  - Standard deviation ≤ 1.5% of average.
  - Maximum power variation ≤ 10 % of average.
  - Heat flux rate between 15 W and 25 W per foot of bore.
- **Undisturbed Soil Temperature** – Shall be determined by recording the minimum loop temp. at startup.
- **Installation Procedures** – Bore dia. ≤ 6". Bore should be grouted bottom to top.
- **Time Between Installation and Testing** – 5 days if grout TC is low (< 0.75 Btu/hr ft °F), otherwise 3 days.

Fundamentals



Results of the Thermal Conductivity Test




S 079

Typical Test Bore

Properly Backfilled


WACKER
G 25
WACKER

TC Test – The Black Box

Sensitivity of loop length to changes in earth thermal conductivity/diffusivity and deep earth temperature.

Starting GX Length: 51,077 (ft.)

Parameter	**Change**	**New GX Length**	**% Change**
Thermal Conductivity/Diffusivity (Decrease)	20%	59,309	~16%
Deep Earth Temperature (Increase)	20%	65,295	~ 27%
Change Both	20%	75,818	~48%

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GeoTec Supplied Drill Logs

JUAB SCHOOL DISTRICT
Nephi, UT - New Red Cliffs Elementary School
Geothermal Soil Analysis

DRILLING LOG - Test Borehole #1
3/20/2007

Location:	S, T, R - if known	N1165.17 E943.97, SW corner, 09-13S-1E, SL b&m
	GPS and Elevation:	N 39 41.602 W 111 49.990 NAD27 CONUS
	Nephi, UT	5,151

Driller:	Bertram Drilling			
State License #:	34		24	Joints on rig
Rig:	Mayhew 1000		15'	Length of Kelly
Drilling Fluid:	water based mud			
Loop:	Brand, size, length	Centennial, 1.25", 810		
Grout:	Cetco Geothermal Grout TC - 0.40			
SPUD/TD	3/20/2007		3/21/2007	
	Spud with Medium Mill Tooth			
	Average ROP - 55-70			

NOTE: Time gaps represent connections or unrelated activity

Surface Water - None encountered

Time Start	End	Activity	Duration Minutes	Depth		Comments
3/20/2007						
9:25	9:27	D	2	0-15	A	top soil, silt & clay
9:35	9:37	D	2	15-30	L	Change to 4-way blade bit brn. Cly, gravel
9:53	10:35	D	42	30-45	L	A/A - Changed to rock bit @ 40', COH,
					U	cobble fall in, had to re-drill 6-7 feet
					V	Coarse gravel and valley fill+/- 40-45'
					I	Oquirrh rubble- cleaned up ledges 10:35-10:40
10:41	10:49	D	8	45-60	A	Oquirrh rubble
10:56	11:01	D	5	60-75	L	A/A - clean up ledges

Juab Elementary Drilling Log.xls

Added:

- Drilling times
- Bits used
- General comments
- Additional pertinent data needed for absent drillers to bid.

11:18	11:25	D	**7**	75-90		brn clay w/ bigger gravel/fill clean up ledges
11:41	12:18	D	**37**	90-105	F	POOH @ 95' - bit jet holes pulgged
					A	12:10 - drill again - coarse gravel and fill w/ brn cly
12:21	12:33	D	**12**	105-120	N	Coarse gravel & fill w/ brn cly
12:39	12:54	D	**15**	120-135		A/A
12:59	13:08	D	**9**	135-150	F	A/A
13:10	13:16	D	**6**	150-165	O	A/A
13:21	13:26	D	**5**	165-180	R	A/A - clean up ledges, and fix cable on rig
13:39	13:48	D	**9**	180-195	M	Coarse gravel & fill w/ brn cly @14:02, had to redrill last 8'
14:07	14:20	D	**13**	195-210	A	Coarse sand & gravel
14:26	14:31	D	**5**	210-225	T	A/A (silty)
14:35	14:41	D	**6**	225-240	I	A/A - w/ brn cly
14:44	14:50	D	**6**	240-255	O	Coarse gravel/fill w/ brn cly
14:54	14:59	D	**5**	255-270	N	A/A
15:06	15:15	D	**9**	270-285		A/A - (worked on rig set-up 15:15-15:25)
15:25	15:48	D	**23**	285-300		Coarse cemented sand & gravel
						snappy, slower drilling 290-300' (approx. 15:30)
15:54	16:20	D	**26**	300-315		A/A - snappy, slower drilling
16:28	16:44	D	**16**	315-330		A/A - snappy, slower drilling
16:52	17:06	D	**14**	330-345		A/A - snappy, slower drilling
17:23	17:39	D	**16**	345-360		A/A - snappy, slower drilling
						320' tremie
		Cond Hole	**15**			POOH 15 bags of grout
Total Drilling Time:			298.00	Minutes		Drilling 0 - 360'
			4.97	Hours		

0 - 40' - Easy drilling through top soil, silt and clay. Balance of hole coarse sand and gravel w/ clay.
Pressure test loop to 115 psi - no leaks.
30 min to POOH. Bit in marginal cond. RIH with U-bend to 355' and tremie to 320'.
RU grout equip, mix grout.

COMMENTS:

Approximately 3500 gallons of water was used for the hole.
The majority of the lithology in test hole was comprised of Oquirrh rubble w/ valley fill and alluvial sand and clay
15 sacks of Cetco Geothermal Grout to 320'

May determine optimum depth.

Commercial Applications for GeoExchange

30,000 Btu/SF

Energy Reduction:

50%

Water Reduction:

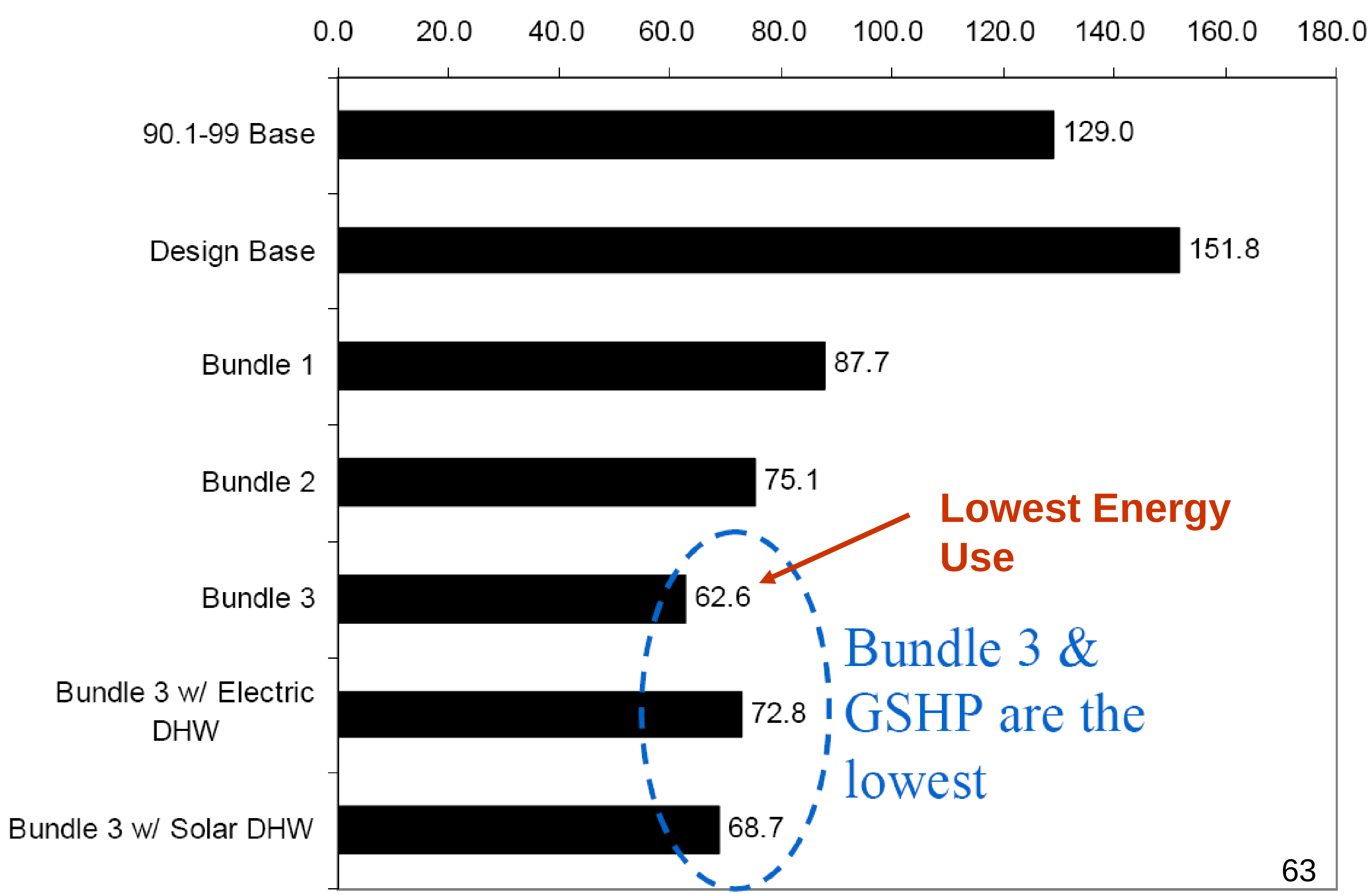
60%

Greenhouse Gas Reduction:

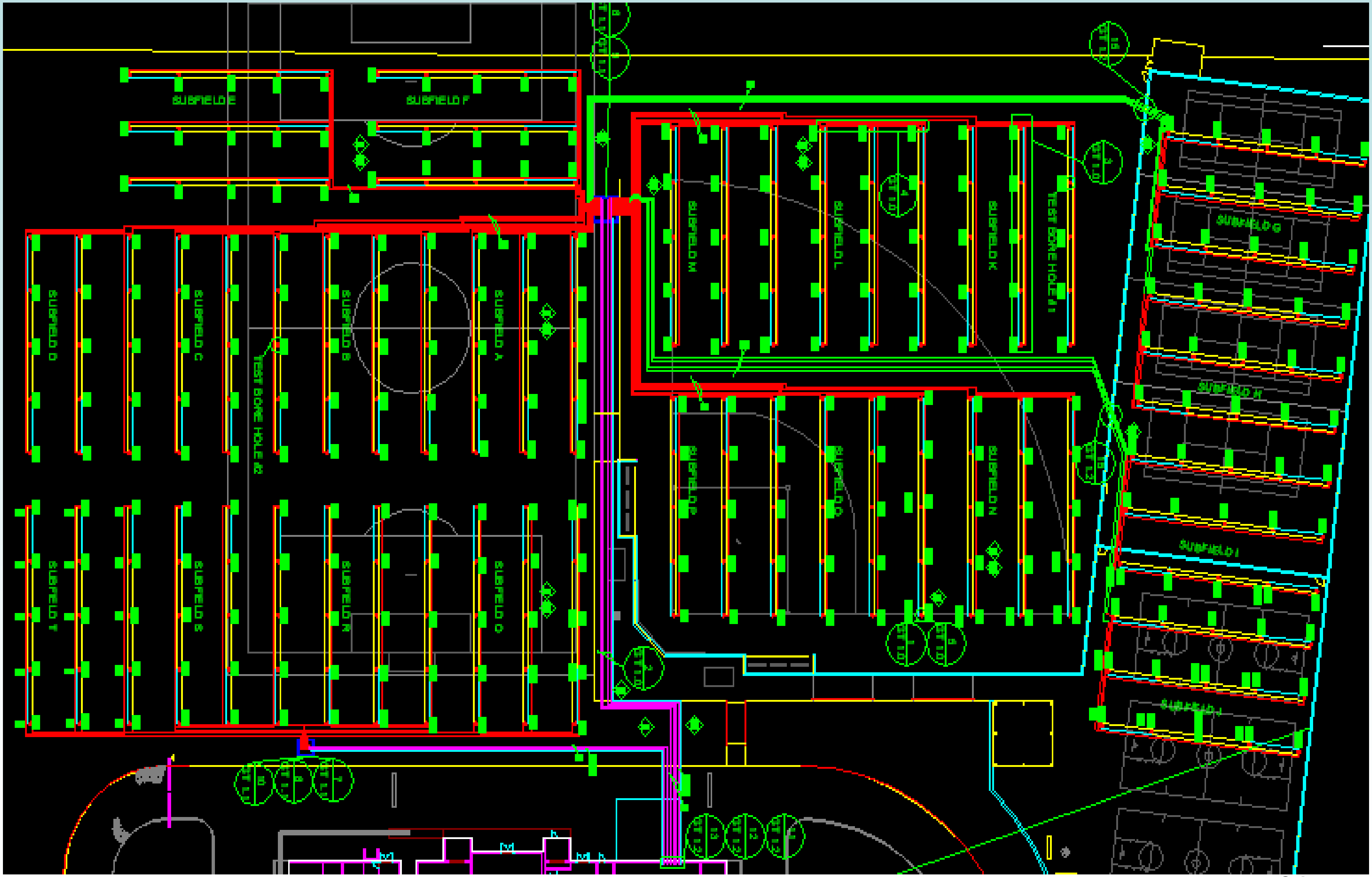
TBD

CCSD
Burkholder Middle School
Energy Performance Solutions

Bundle Results – KBtu/SF at *source*



Borefield: 300 boreholes, 300’ deep




2006/09/27 2:58 pm


2006/08/02 10:23 am


2006/11/02 12:54 pm


MPS
1010200
58146-3
STEPS


Burkholder #713-08
View SE
D1206-9-31
12/14/06

Las Vegas Motor Speedway

BERTRAM DRILLING & LOOPMASTER

Duchesne High School

Duchesne High School

Questions?

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