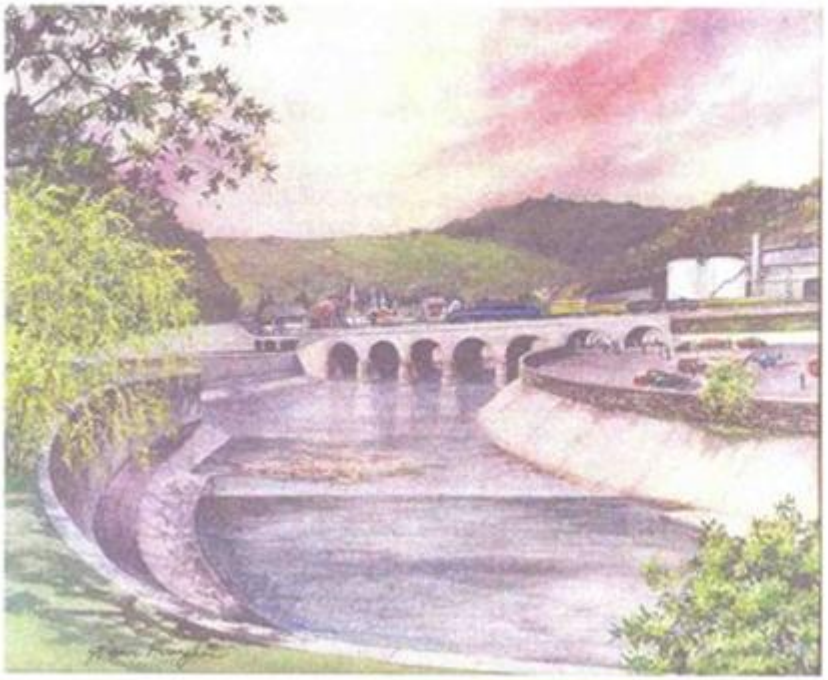
Greater Johnstown Watershed Association



Working With:

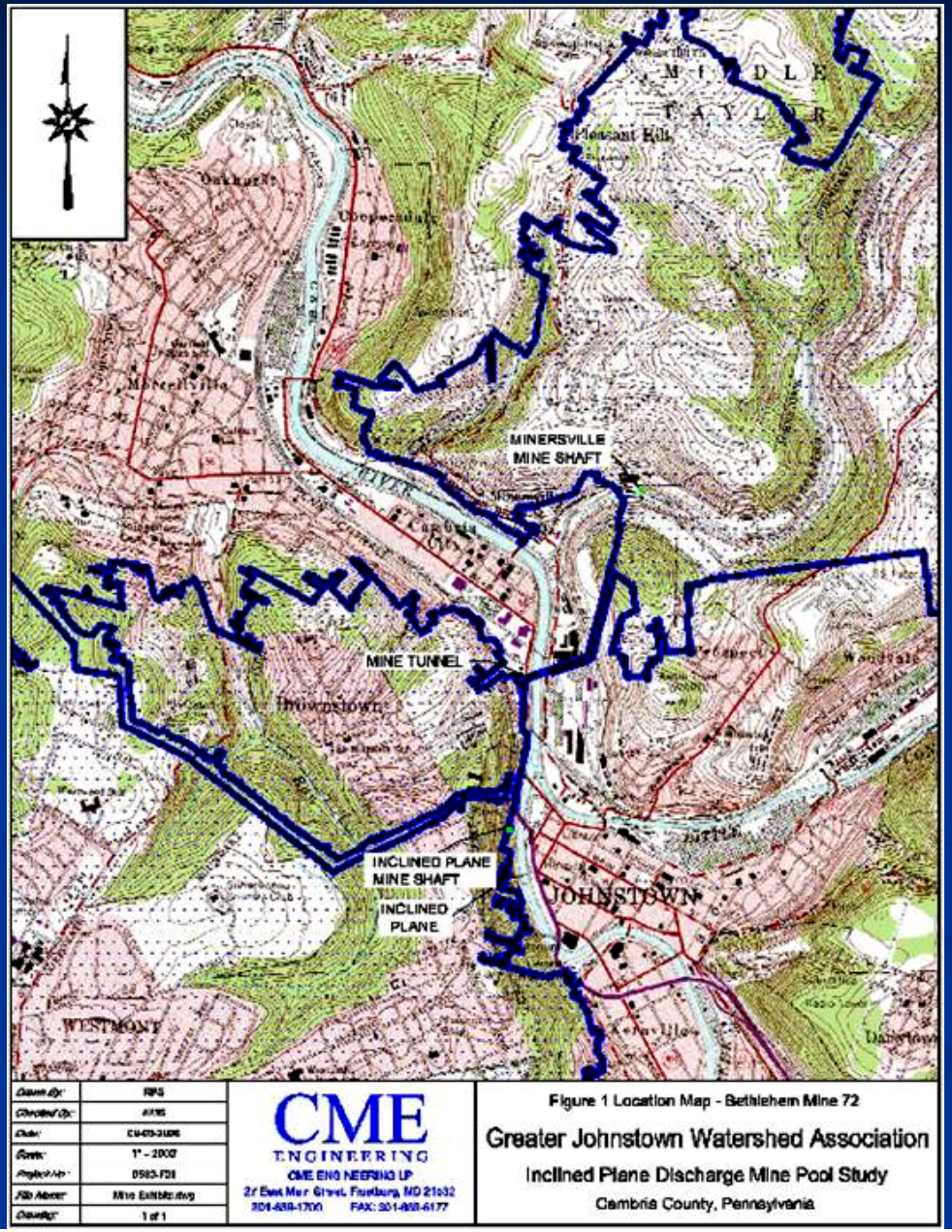
CME ENGINEERING

Foundation for Pennsylvania Watersheds

Inclined Plane Study
Johnstown, PA
Greater Johnstown Watershed Association and CME Engineering LP

Inclined Plane Discharge (Q)

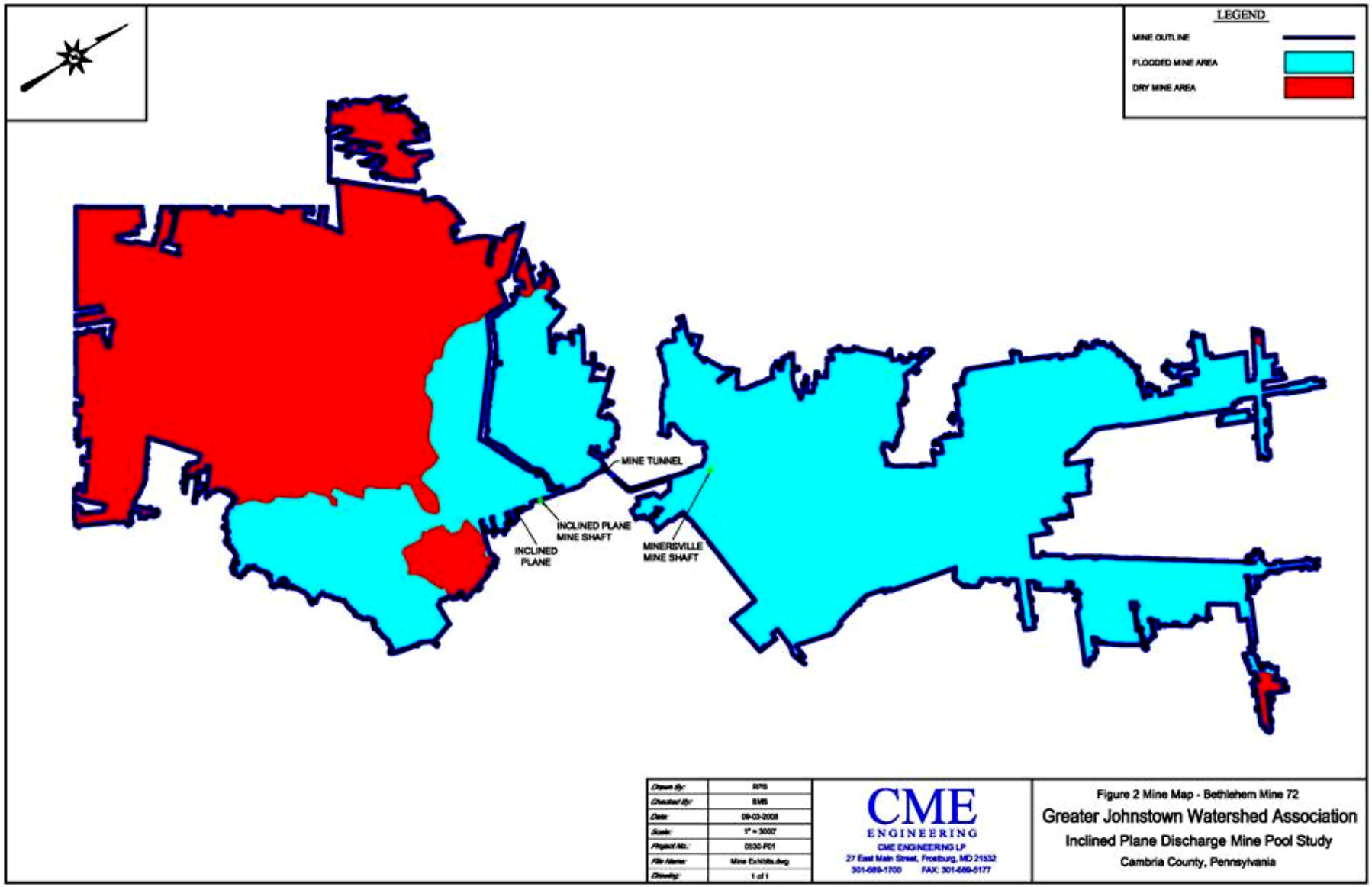
Extent of Mine 72



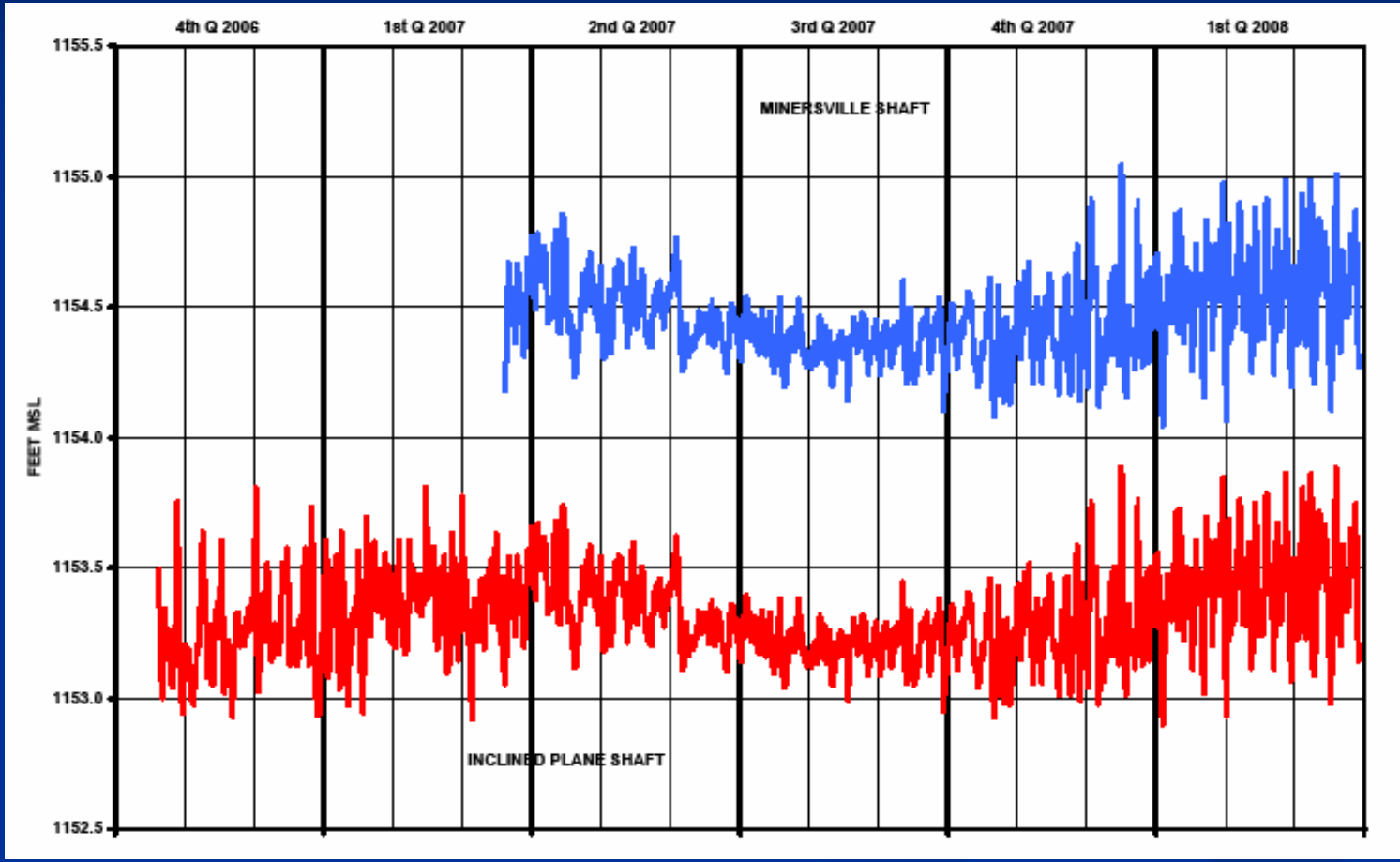
Bethlehem Mine 72

- Lower Kittanning seam
- Mined out area ≈ 8,540 acres
- Mine pool area ≈ 5,000 acres
- Pool volume ≈ 3.9 billion gals. (60% extraction and 4 ft void height)

Mine 72 mine pool



Mine pool elevations



Discharge culvert at Inclined Plane

Weir at Inclined Plane

Inclined Plane Q

- Median 444 gpm
- Maximum 1000 gpm
- Minimum 150 gpm

Water Chemistry (median values) June 2004 – March 2008

- pH (field) 5.8
- Hot Acidity 363 mg/L
- Alkalinity 58 mg/L
- Total Manganese 2.1 mg/L
- Iron
  - Total 231 mg/L
  - Ferrous 239 mg/L
  - Ferric 0.0 mg/L

Iron mound

Acidity Load

- Median Q 1628 lbs/day
- Maximum Q 3510 lbs/day

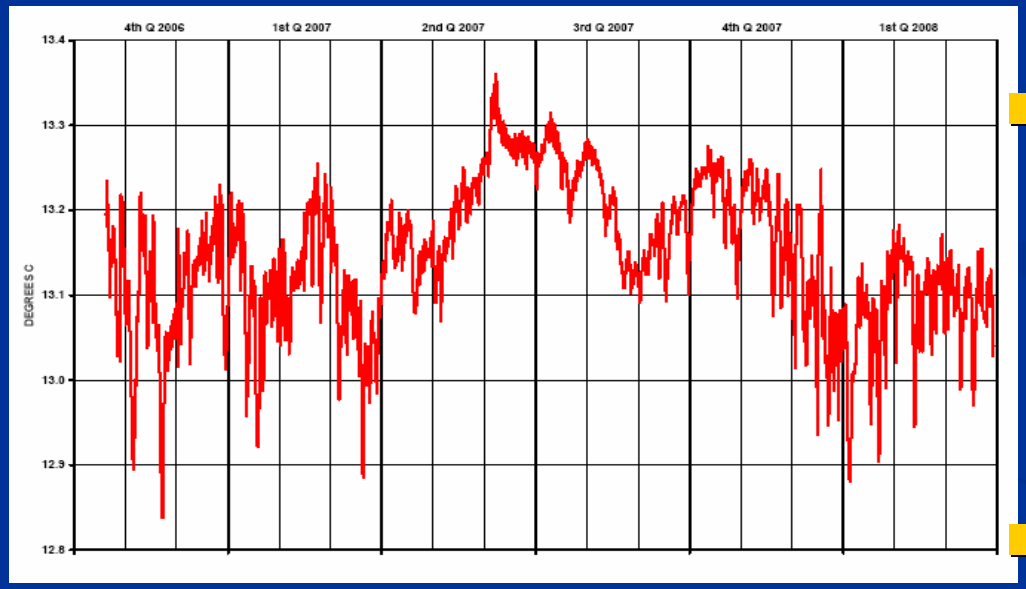
Estimated Costs Associated with Options

		Initial Capital Cost	Annual Operational Cost	Cost per 1000 Gallons Treated
1.	Leave discharge as-is	$0	$0	N/A
2.	Relocate discharge			
	a. Adjacent under water in river	$46,000	$0	N/A
	b. Downstream of Point	$215,000	$0	N/A
	c. To western end of town	$1,775,000	$0	N/A
3.	Sewage treatment	$273,000	$165,000	$0.76
4.	Pump and treat			
	a. Small plant (0.75 mgd cap.) treating at 0.75 mgd	$1,130,000	$515,000	$1.88
	b. Large plant (2.88 mgd cap.) treating at 0.75 mgd	$1,260,000	$520,000	$1.90
	c. Large plant (2.88 mgd cap.) treating at 2.88 mgd	$1,260,000	$1,810,000	$1.72

Eliminating Inclined Plane Q

- Lower pool elevation to 1150 ft
- Mine pool area reduced by about 87 acres
- Pool volume reduced by about 11 million gals.
- (≈ 3% reduction)
- Leaves about 3.8 billion gals. for geothermal

Water temperature Inclined Plane shaft

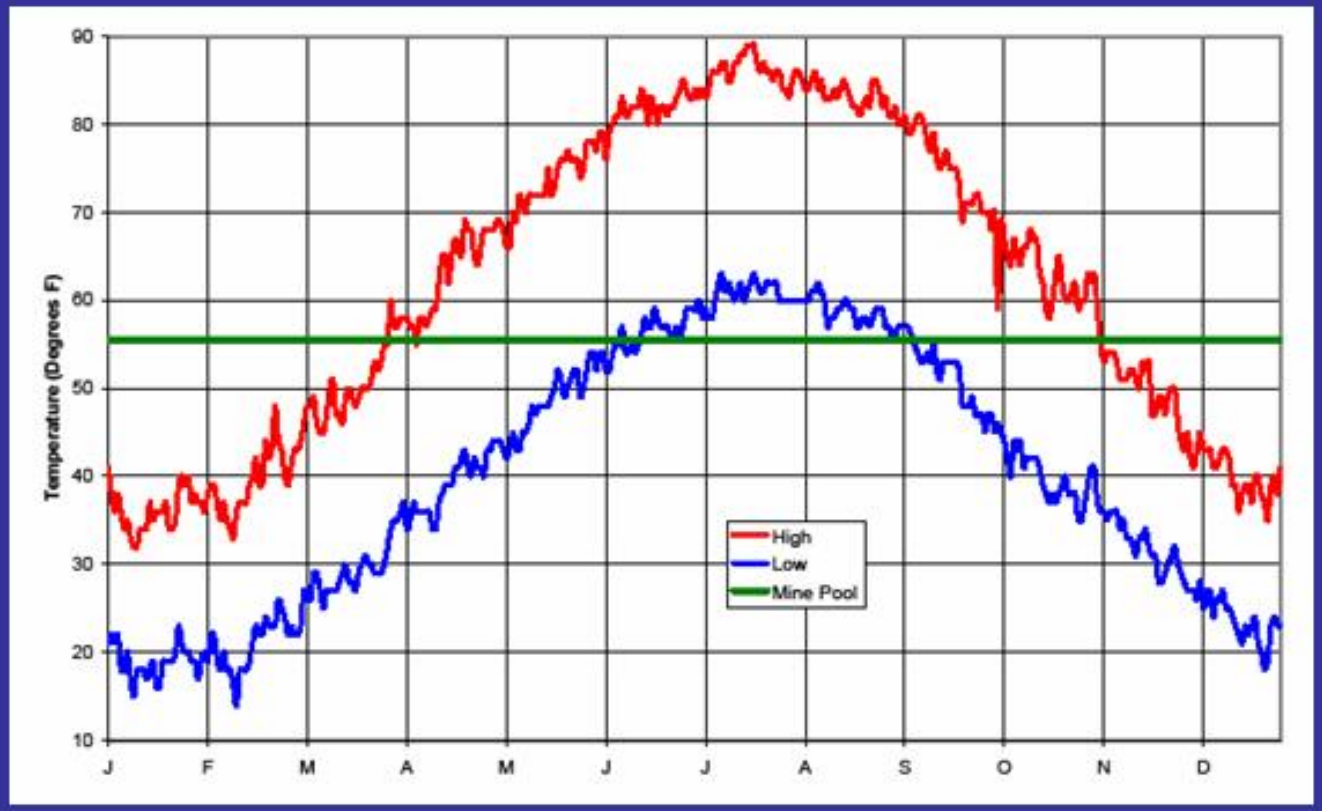


- 56° F
- 55° F

Comparison of geothermal and conventional heat sources

Energy Source	Cost per Million Btu	% Savings at COP = 3.0	% Savings at COP = 4.0
Propane	$39.70	78 %	83 %
Electrical Resistance	$26.69	67 %	75 %
Fuel Oil	$35.09	75 %	81 %
Natural Gas	$21.14	58 %	68 %

JOHNSTOWN PA AVERAGE TEMPERATURE



Water in the mine pool is at constant temperature year-round.

This requires less energy to run heat pumps in winter and air conditioning in summer.

Geothermal vs. air source heat pump

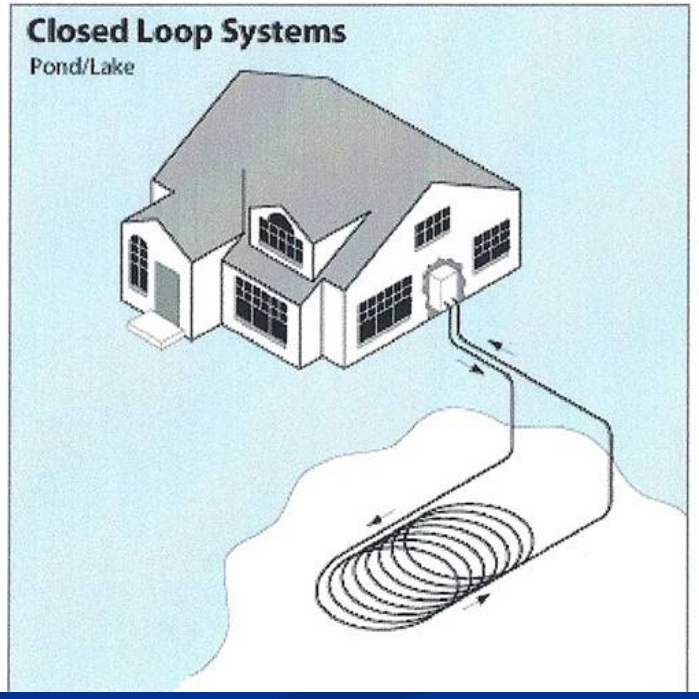
Energy Source	Cost (per million Btu)
Air-source (seasonal average, COP*=2.5)	$10.68
Geothermal COP=3.0	$8.90
Geothermal COP=3.5	$7.63
Geothermal COP=4.0	$6.67
Geothermal COP=6.0	$4.45

** COP is the coefficient of performance based on Sept, 2008 regional costs*

Closed Loop System

Pond/Lake Geothermal Systems

- If the site has an adequate water body, this may be the lowest cost option.
- A supply line pipe is run underground from the building to the water and coiled into circles at least eight feet under the surface to prevent freezing.
- The coils should only be placed in a water source that meets minimum volume, depth, and quality criteria.



- Ex. Cornell University

Open Loop System Draws Water from Mine

Water is Pumped to Heat Exchangers at Buildings

Treated Water is Discharged to River or Returned to Mine

Beth 72 Mine Pool
Geothermal capacity Estimates

	Flow gpm	Cubic ft heated/ cooled	Homes supplied	MWh per yr. saved	Savings per yr.
Median flow	440	577,926	89	1,940	$177,000
2,000 gpm treatment plant	2,000	2,603,269	400	8,740	$796,000

Geothermal capacity based on USDOE estimates

- 1,300 ft^3 heating-cooling capacity/gpm
- 5 gpm usage for typical home
- Savings are vs. conventional electric heating and cooling systems, price /Kwh as of Oct. 2008

- Approximately 2,000 square miles of flooded abandoned mine workings underlie the northern Appalachian region.
- The Bethlehem Mine 72 Pool at Johnstown covers 4,969 acres and contains 3.89 billion gallons of water.
- An additional 270 million gallons exists in other mines surrounding the City of Johnstown.

Next Steps

- Funding for:
  - Pump test
  - Geothermal heating and cooling feasibility study