UTES – RENEWABLE ENERGY STORES BENEATH OUR FEET

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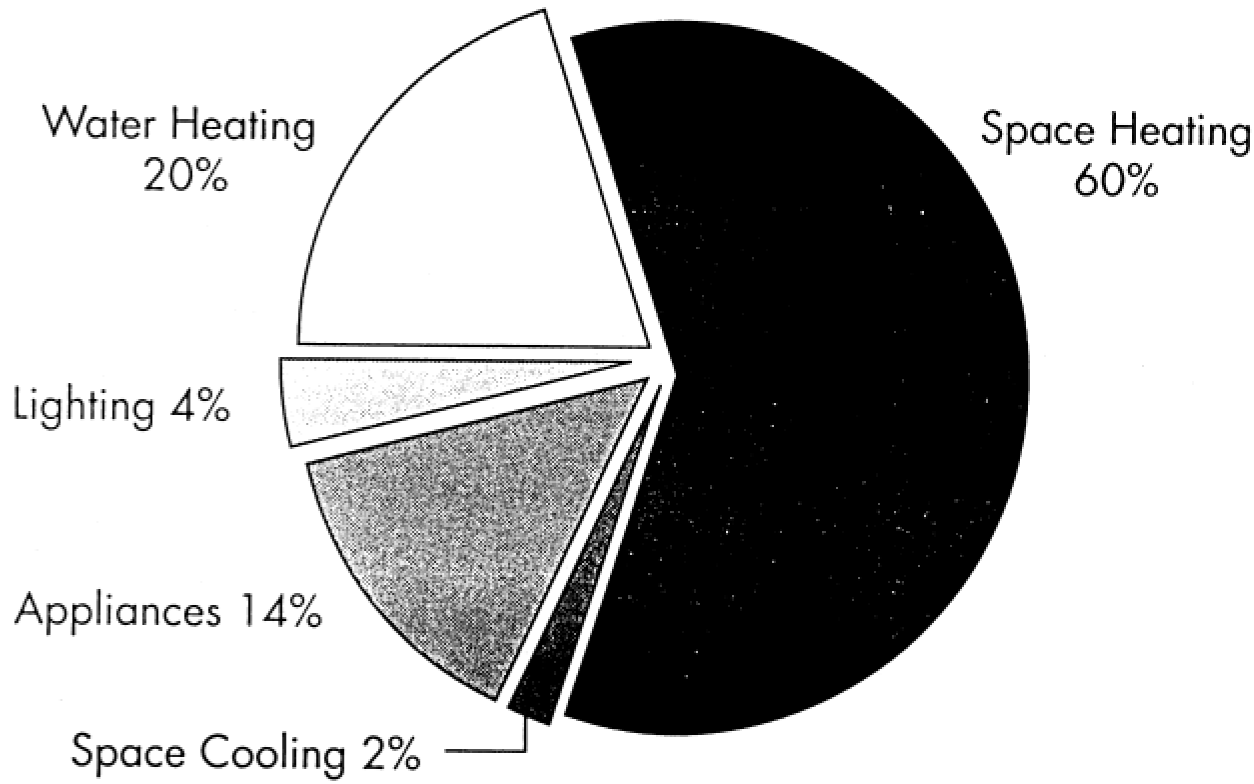
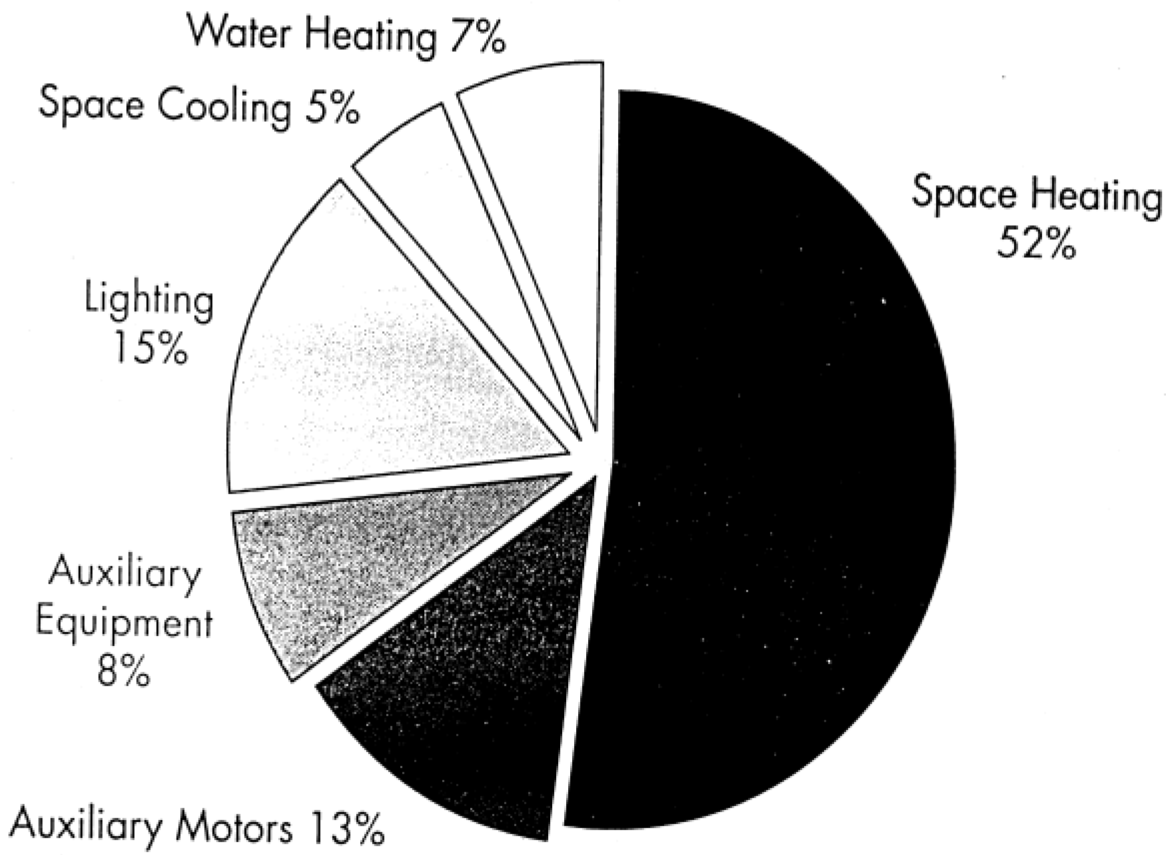
Institute of Environmental Science
Carleton University
Ottawa, Canada

Figure 6: Residential Energy Use, 1997

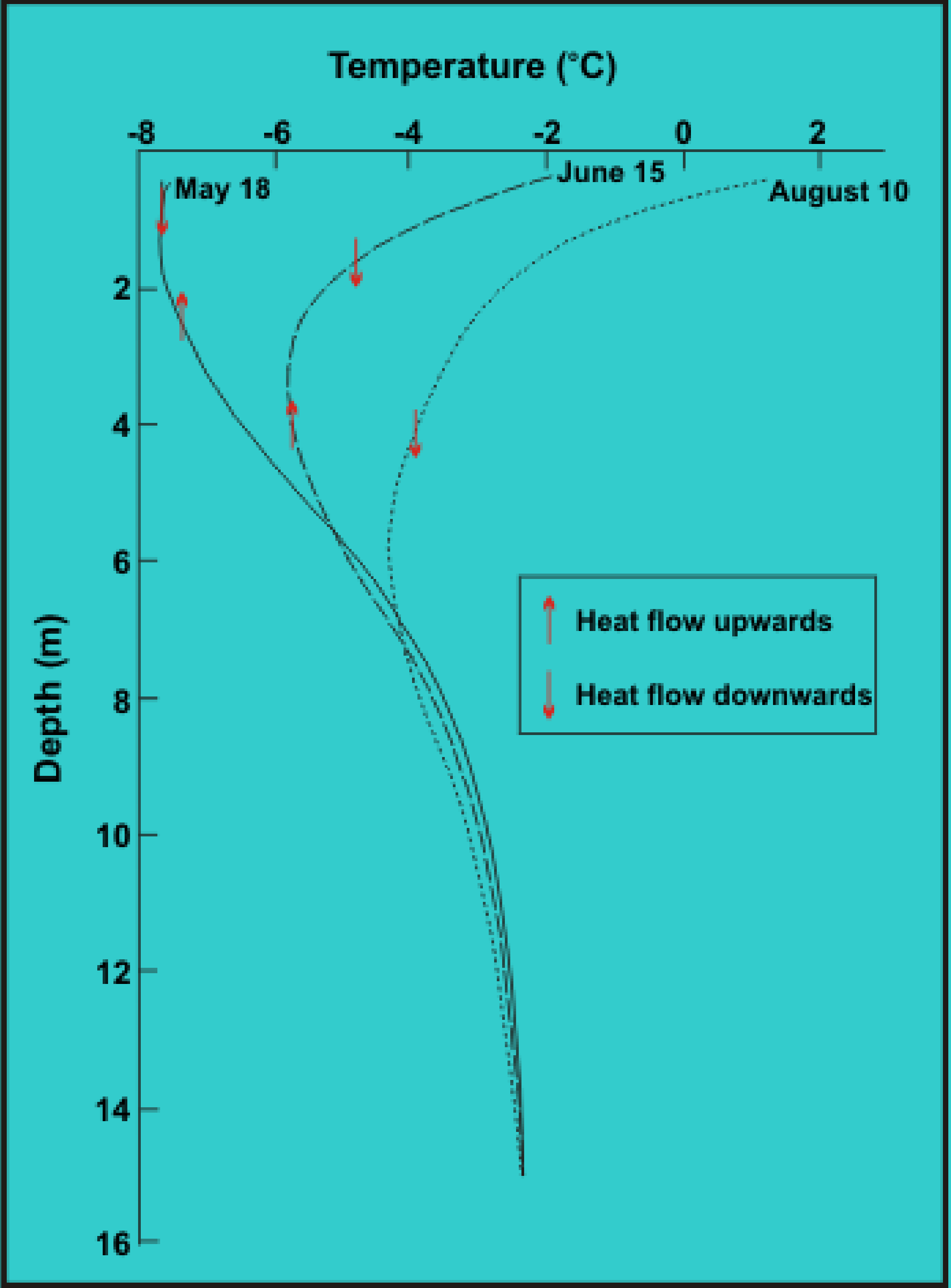


Total: 1 385 Petajoules

Figure 18: Commercial and Institutional Energy Demand, by End Use, 1997



Total: 1 015 Petajoules



Temperature (°C)
-8
-6
-4
-2
0
2
May 18
June 15
August 10
Depth (m)
2
4
6
8
10
12
14
16
Heat flow upwards
Heat flow downwards

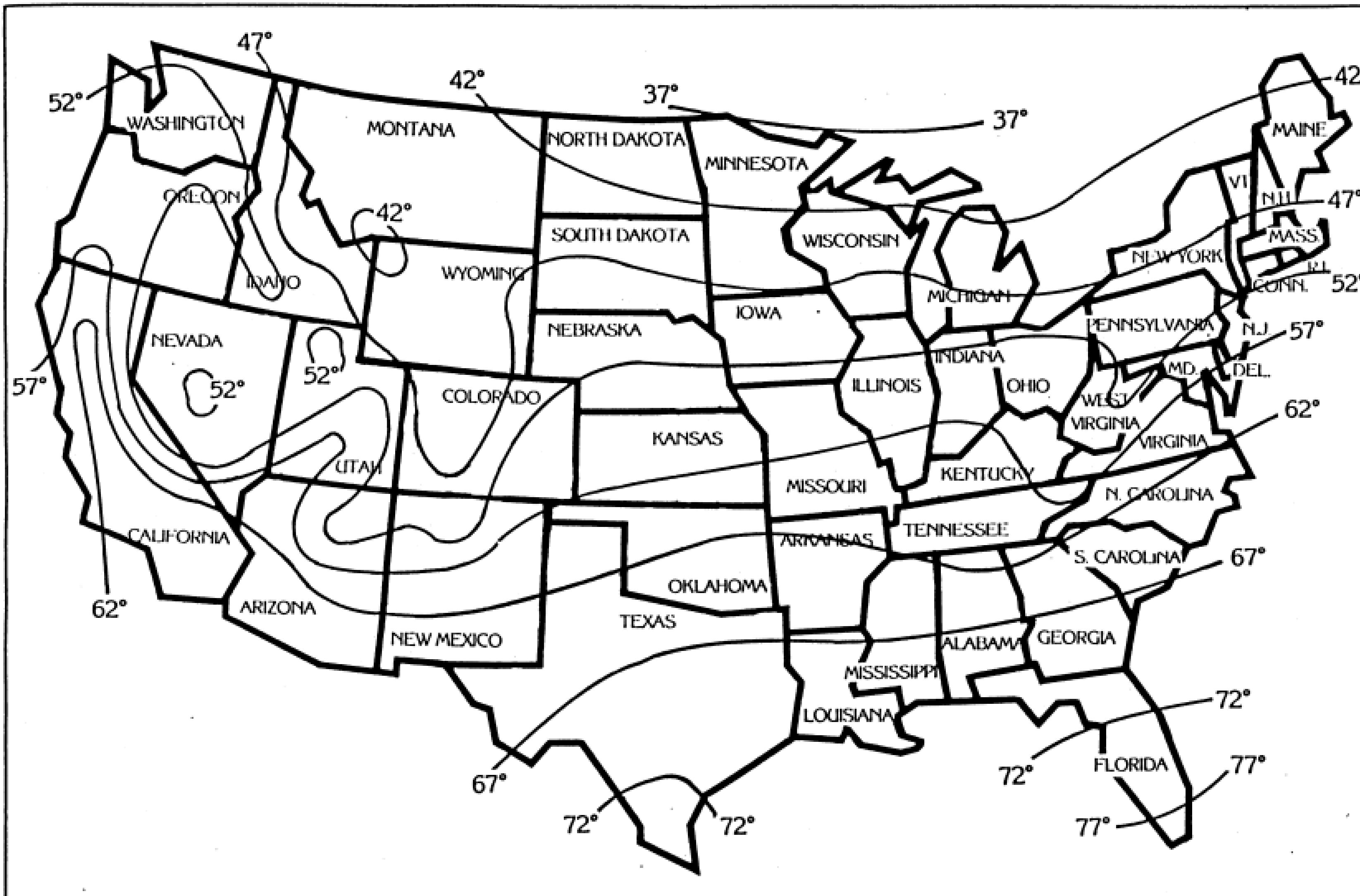
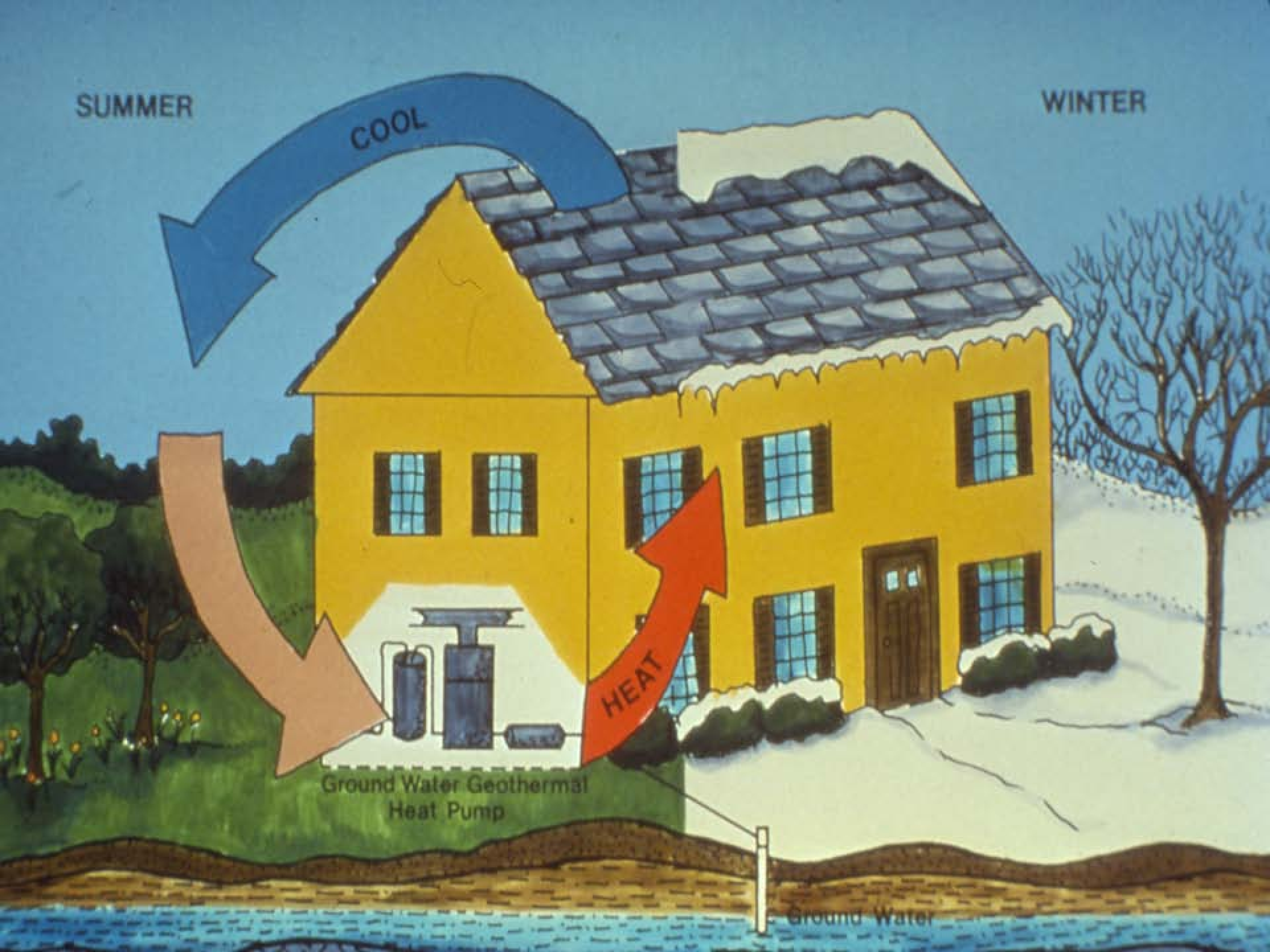
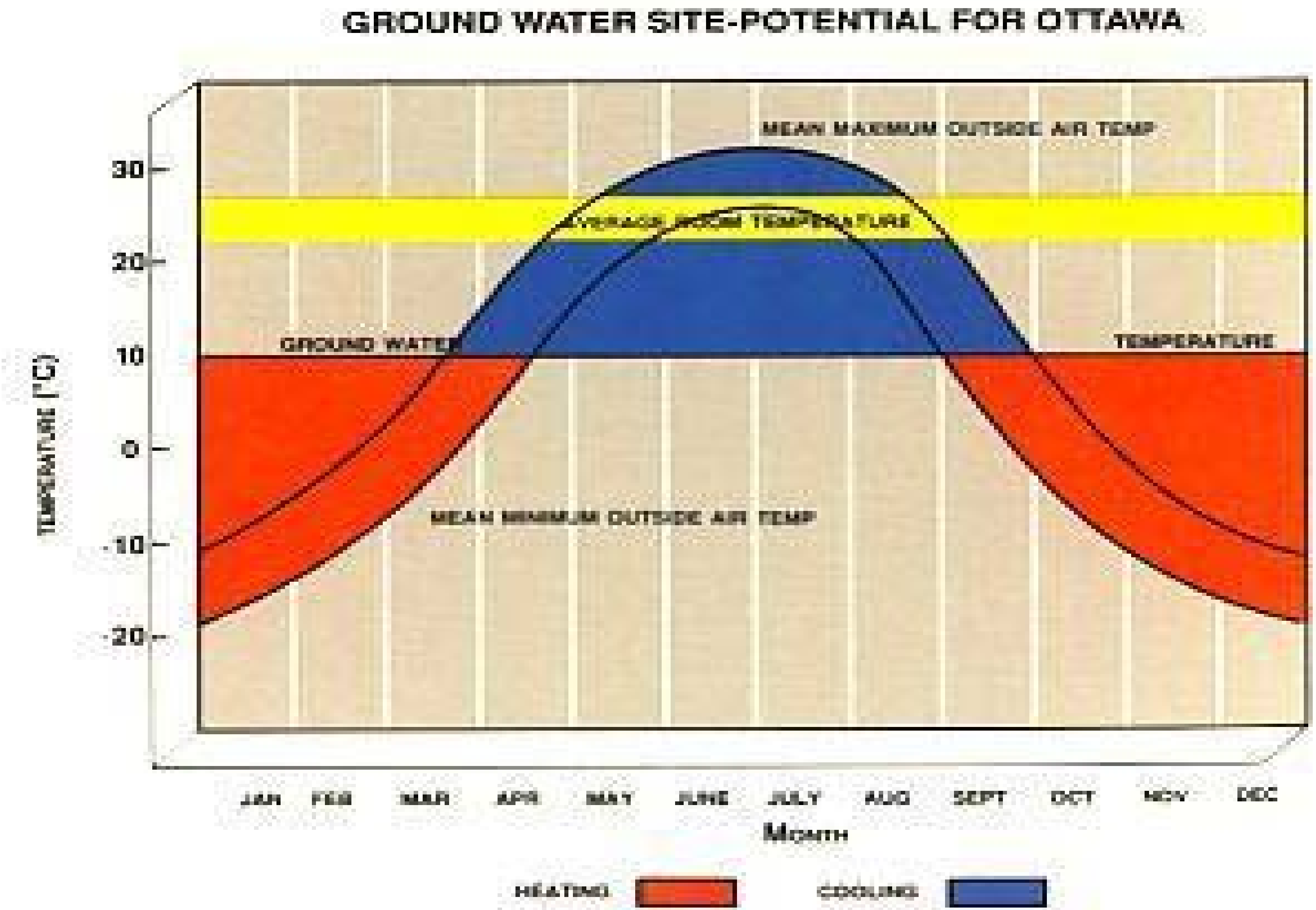


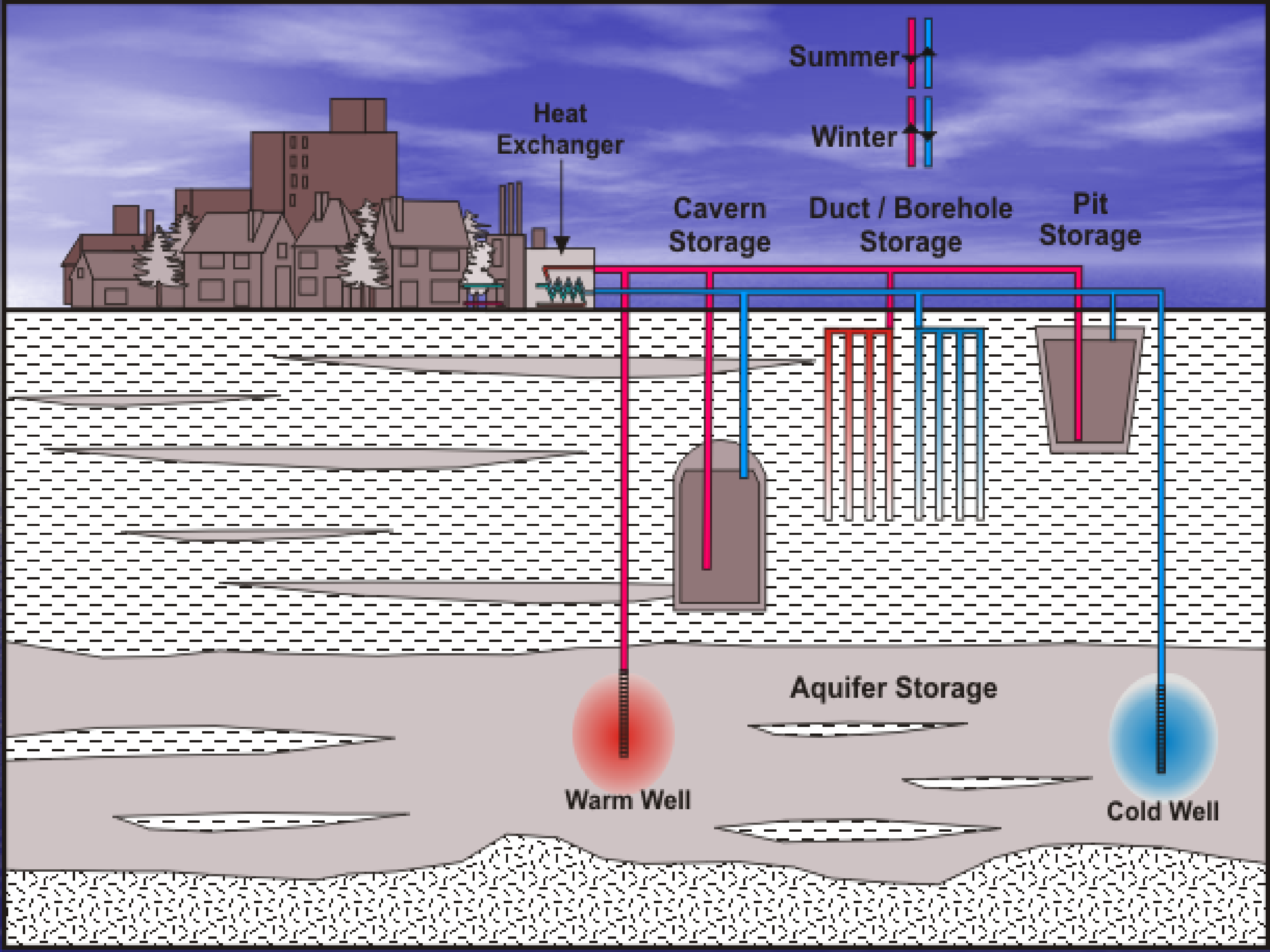
FIGURE 6. Average temperature of shallow ground water F (Popular Science)

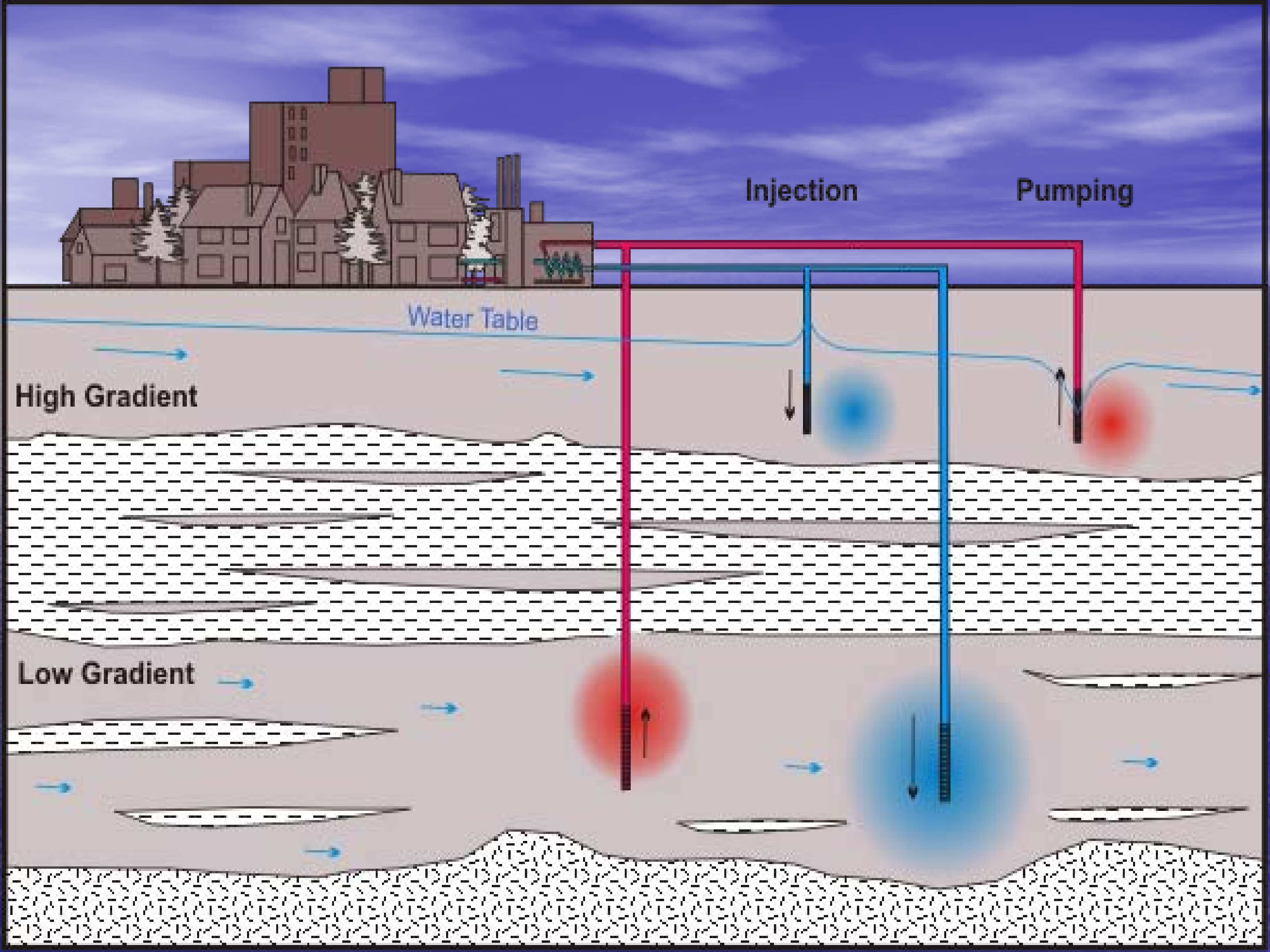

SUMMER
WINTER
COOL
HEAT
Ground Water Geothermal
Heat Pump
Ground Water



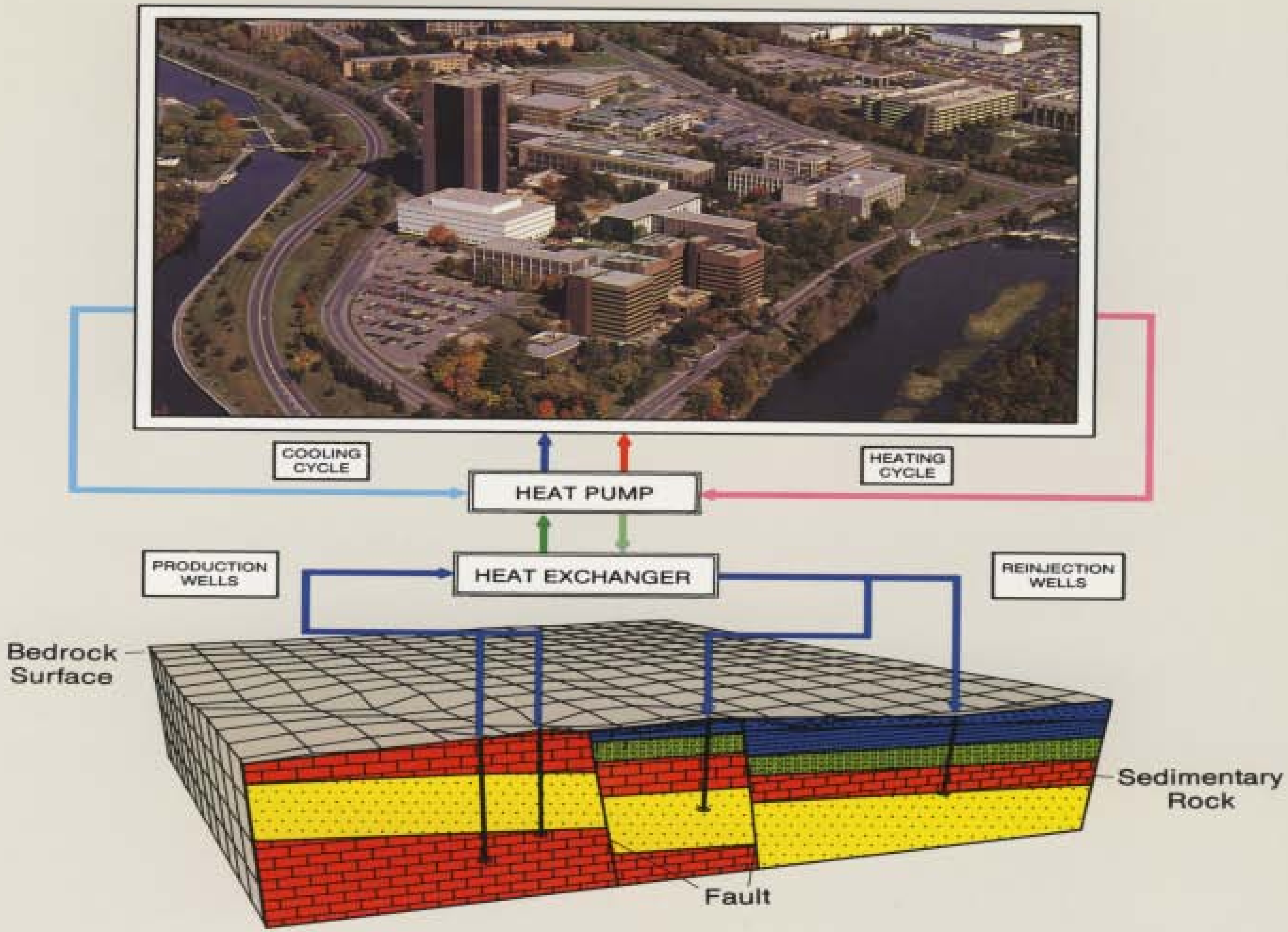
GROUND WATER SITE-POTENTIAL FOR OTTAWA
MEAN MAXIMUM OUTSIDE AIR TEMP
AVERAGE ROOM TEMPERATURE
GROUND WATER
TEMPERATURE
MEAN MINIMUM OUTSIDE AIR TEMP
TEMPERATURE (°C)
30
20
10
0
-10
-20
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
MONTH
HEATING
COOLING


HEATING WATER
YORK
HEAT PUMP-3
YORK
YORK


Summer
Winter
Heat Exchanger
Cavern Storage
Duct / Borehole Storage
Pit Storage
Aquifer Storage
Warm Well
Cold Well


Injection
Pumping
Water Table
High Gradient
Low Gradient

How it Works



A sectional view of the Carleton University campus showing the rock structure and the wells.


Carleton University
Ground Water
Heat Pump
Project
Université Carleton
Projet de
Pompage de
la chaleur de la
nappe phréatique
CARLETON
UNIVERSITY


N
Chelsea
OTTAWA
Carleton University
Gloucester Fault
0
4km

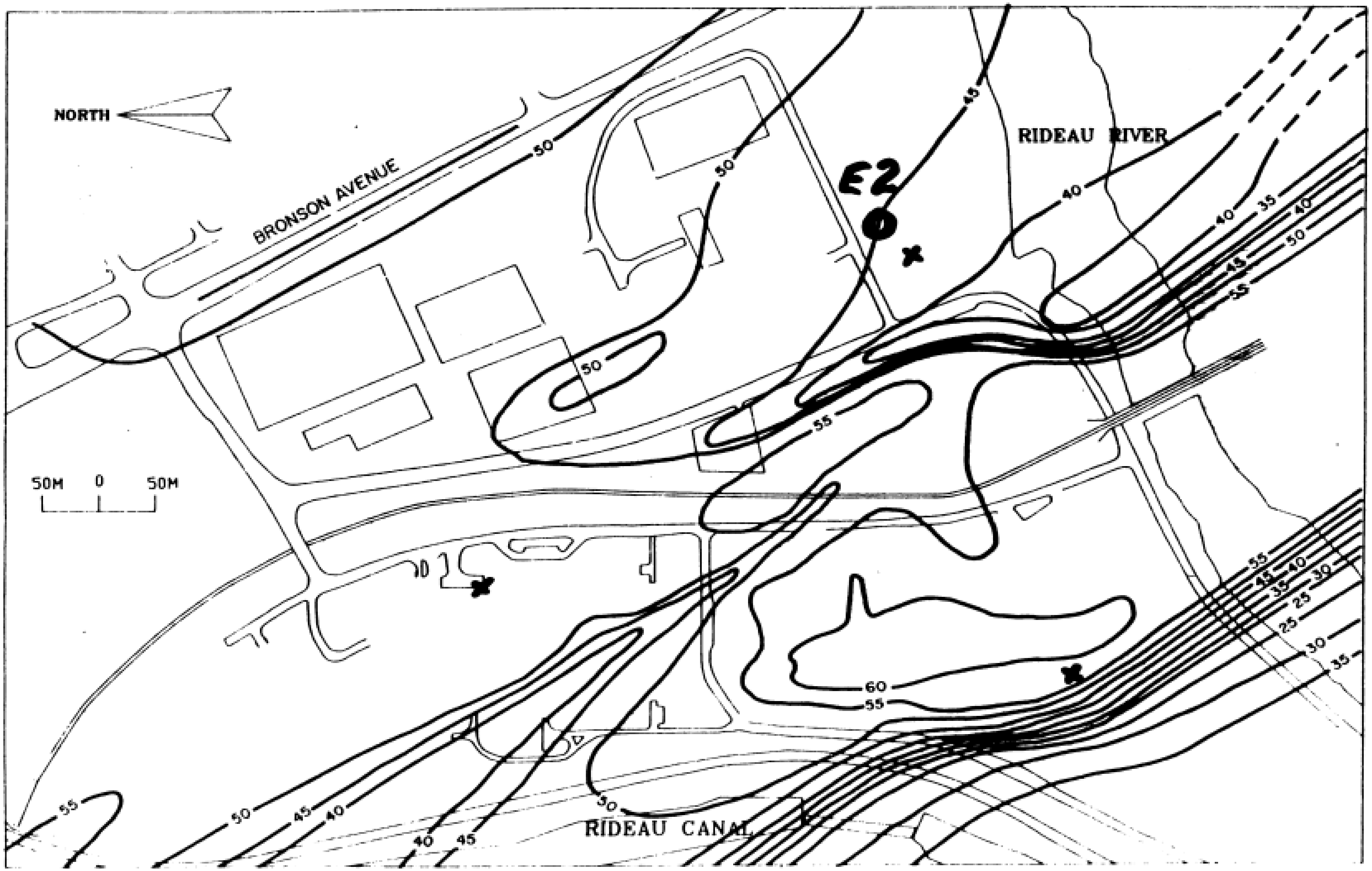


Figure 11 Bedrock surface contours in metres above sea level. Contour interval 5 m.

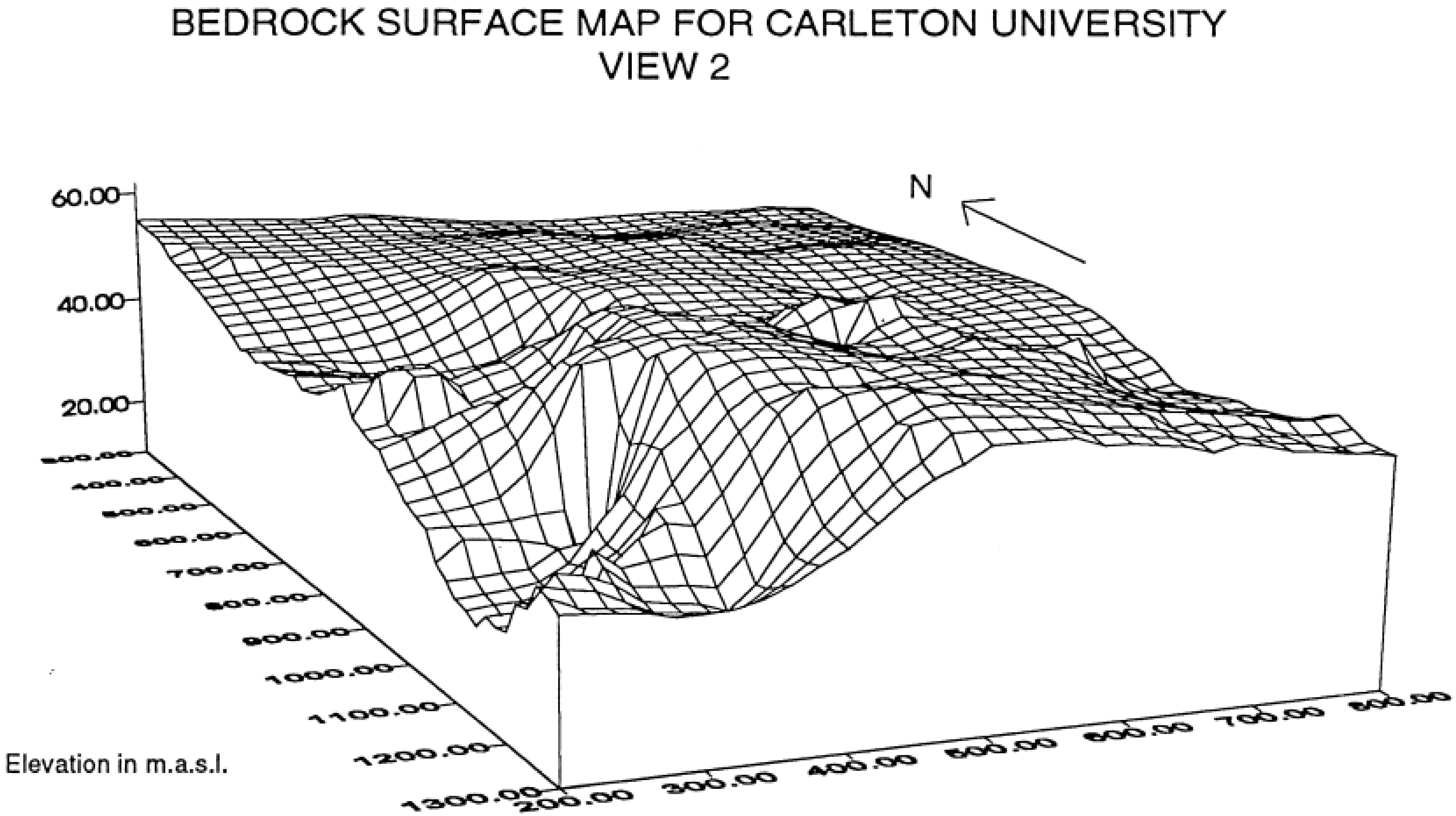


Figure 2.9b : Bedrock Surface Map Looking Northeast


Canada

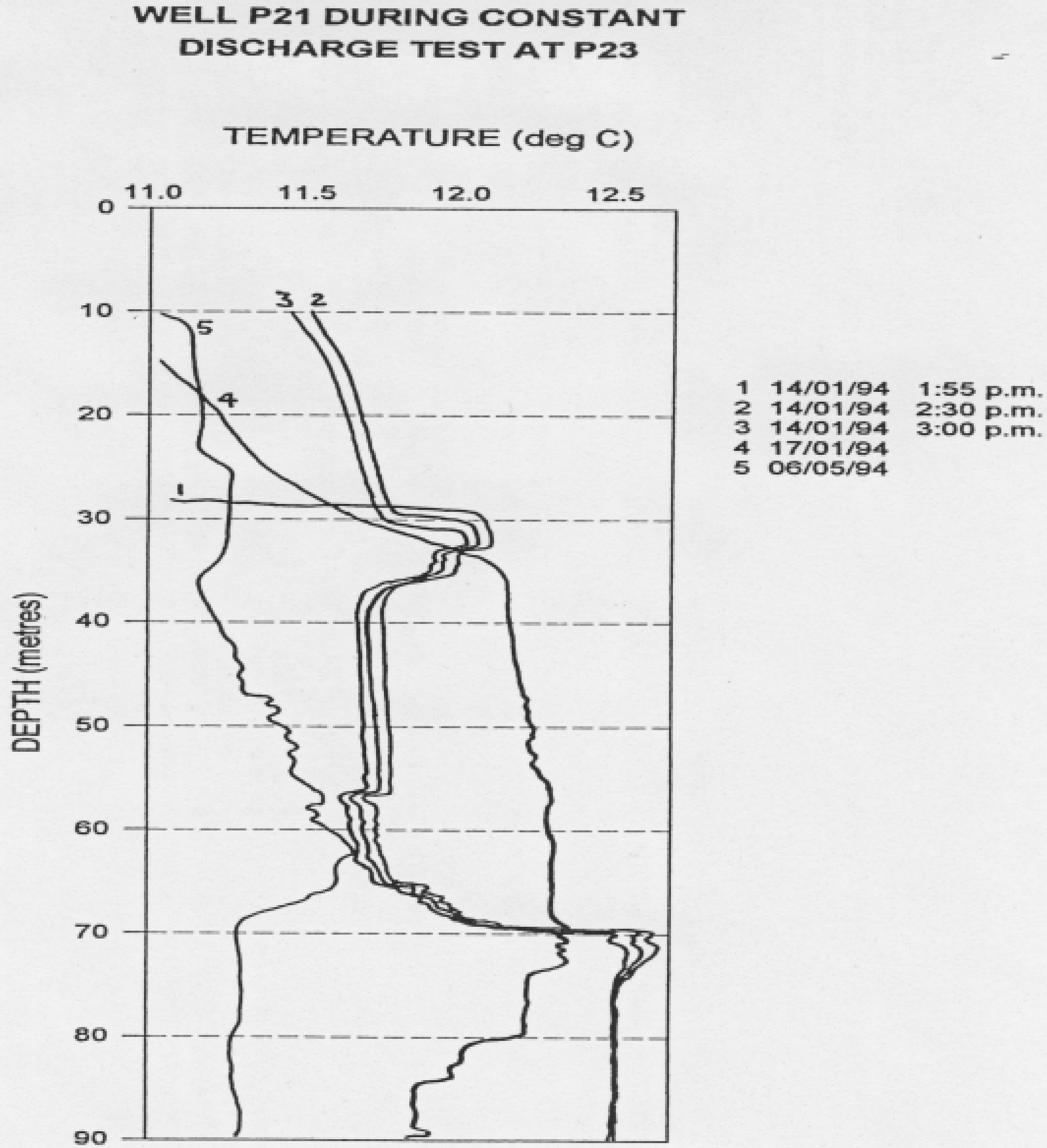
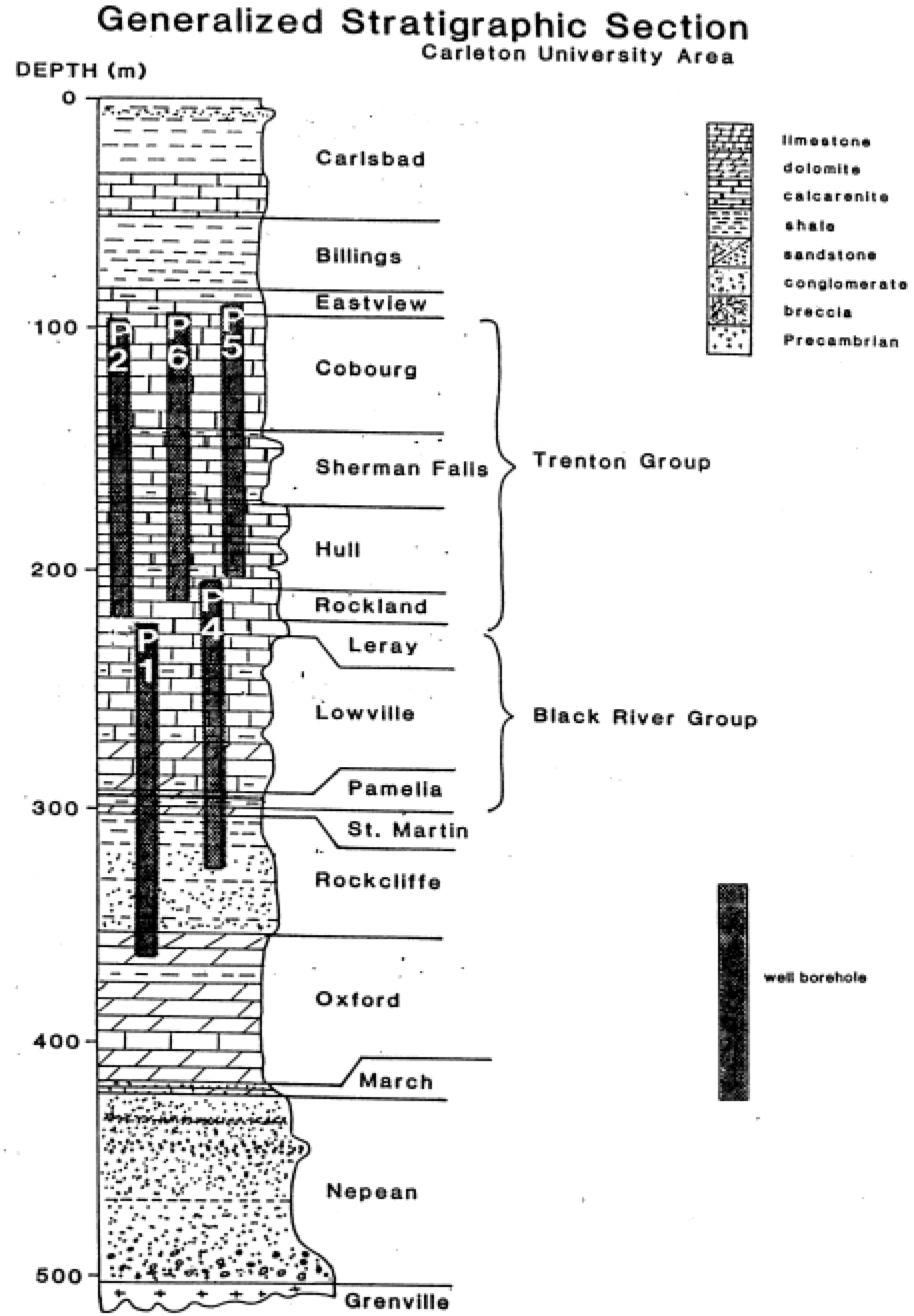
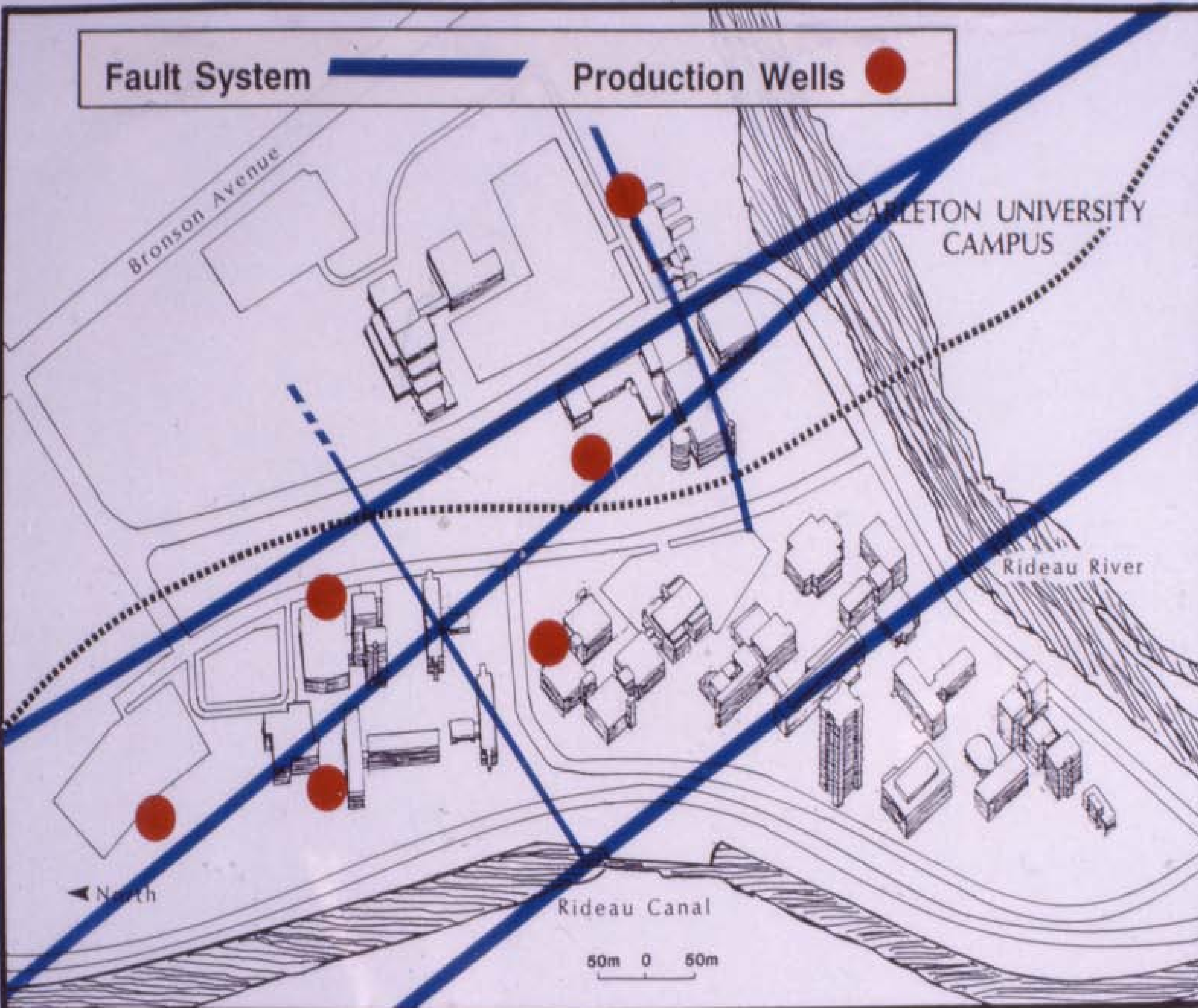


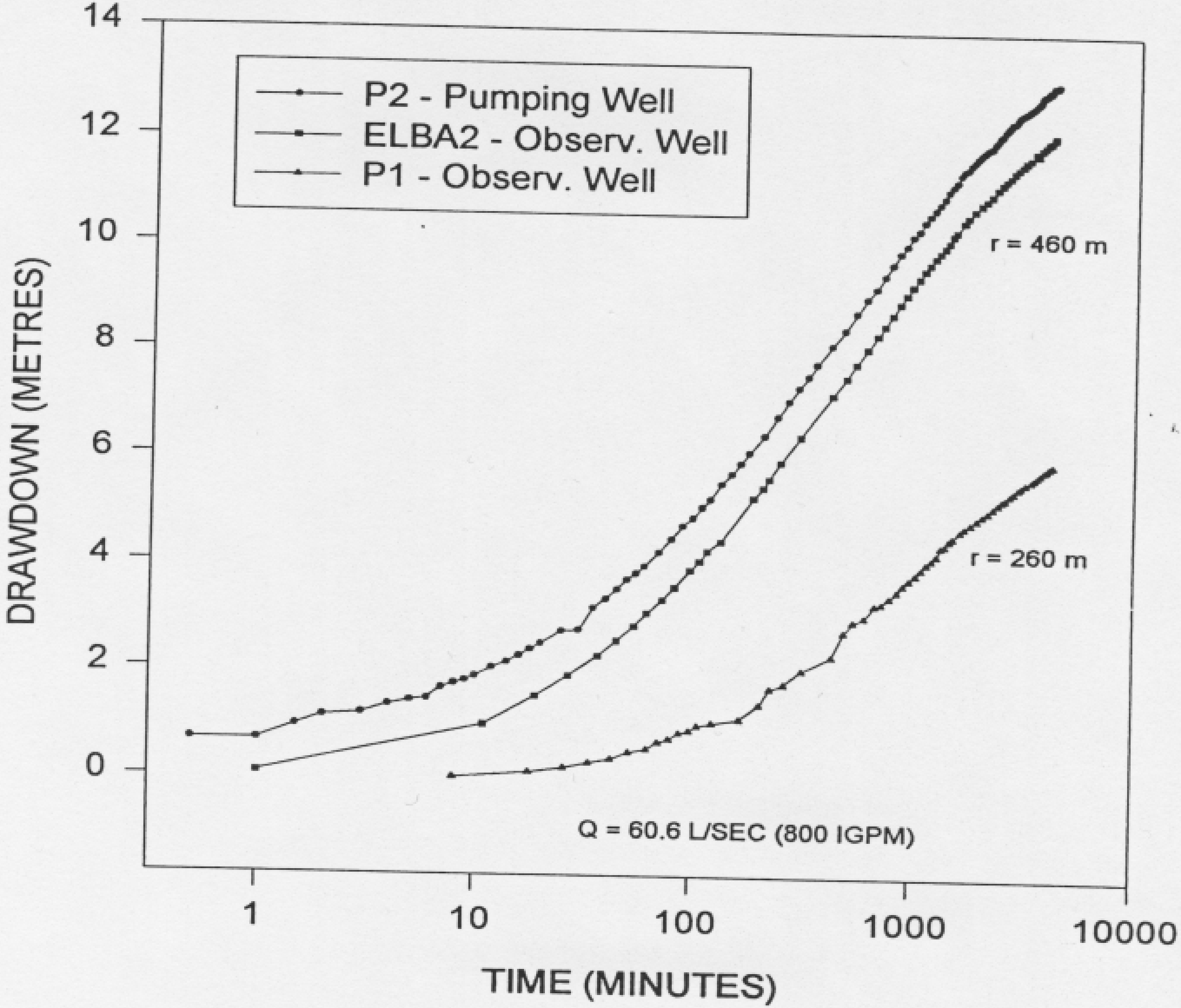
Figure 3.10: Temperature Logs for Well P21 During Constant Discharge Test at Well P23. Test Began at 11:00 a.m. Jan. 14, 1994 and Ended at 8:00 p.m. on Jan. 16, 1994


Generalized Stratigraphic Section
Carleton University Area
DEPTH (m)
0
100
200
300
400
500
P 2
P 6
P 5
P 4
P 1
Carlsbad
Billings
Eastview
Cobourg
Sherman Falls
Hull
Rockland
Trenton Group
Leray
Lowville
Pamelia
Black River Group
St. Martin
Rockcliffe
Oxford
March
Nepean
Grenville
limestone
dolomite
calcarenite
shale
sandstone
conglomerate
breccia
Precambrian
well borehole



Fault System
Production Wells
Bronson Avenue
CARLETON UNIVERSITY
CAMPUS
Rideau River
North
Rideau Canal
50m 0 50m

AQUIFER TEST DATA
CONSTANT DISCHARGE TEST AT WELL P2



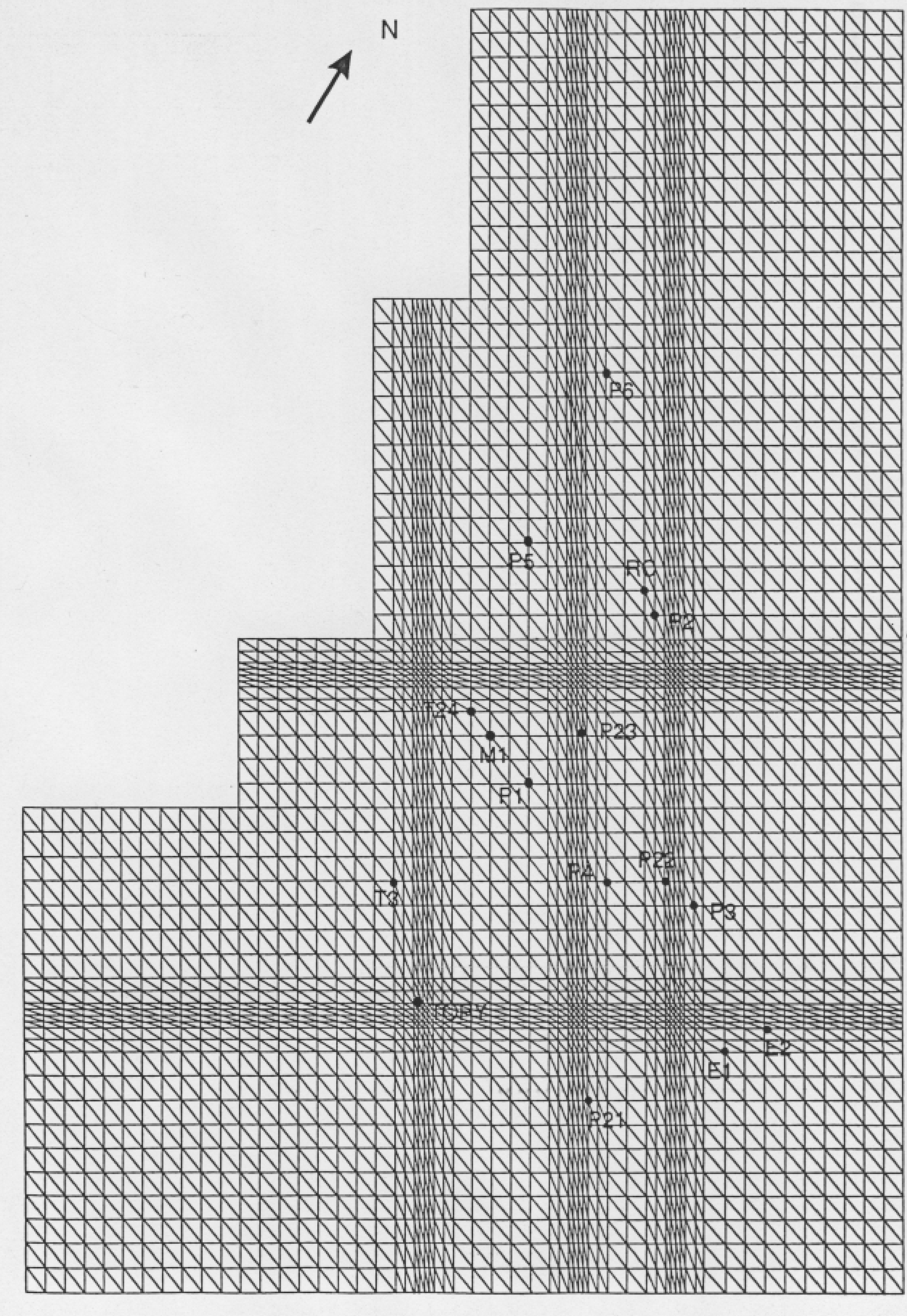


Figure 5.3: Diagram Showing Well Placement for Model

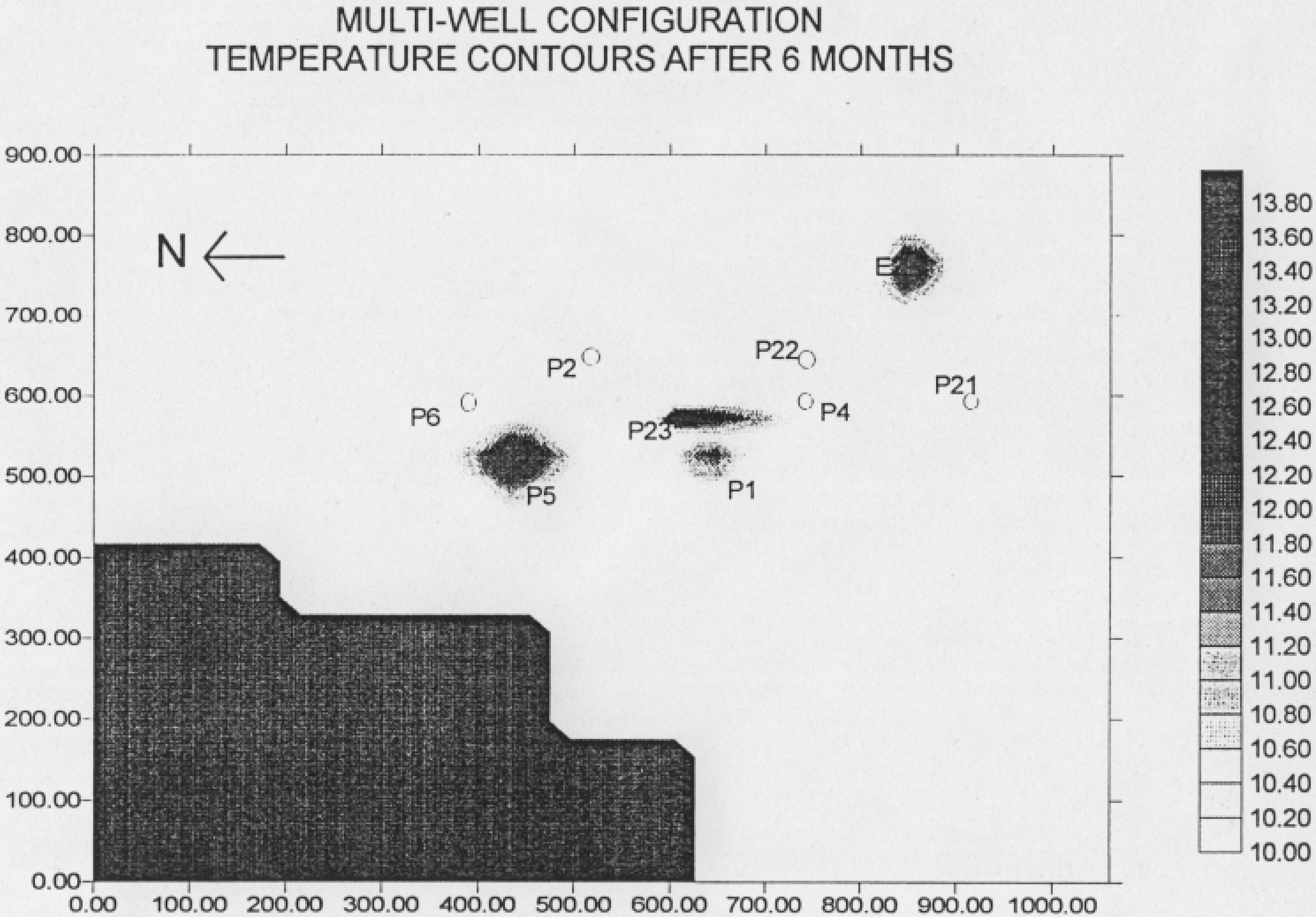


Figure 8.12b: Contour Map of Temperatures at the End of 6 Months for the Multi-well Configuration (CESI, 1994). Total Production Rate is 265 L/s. Aquifer Thickness is 60 Metres.

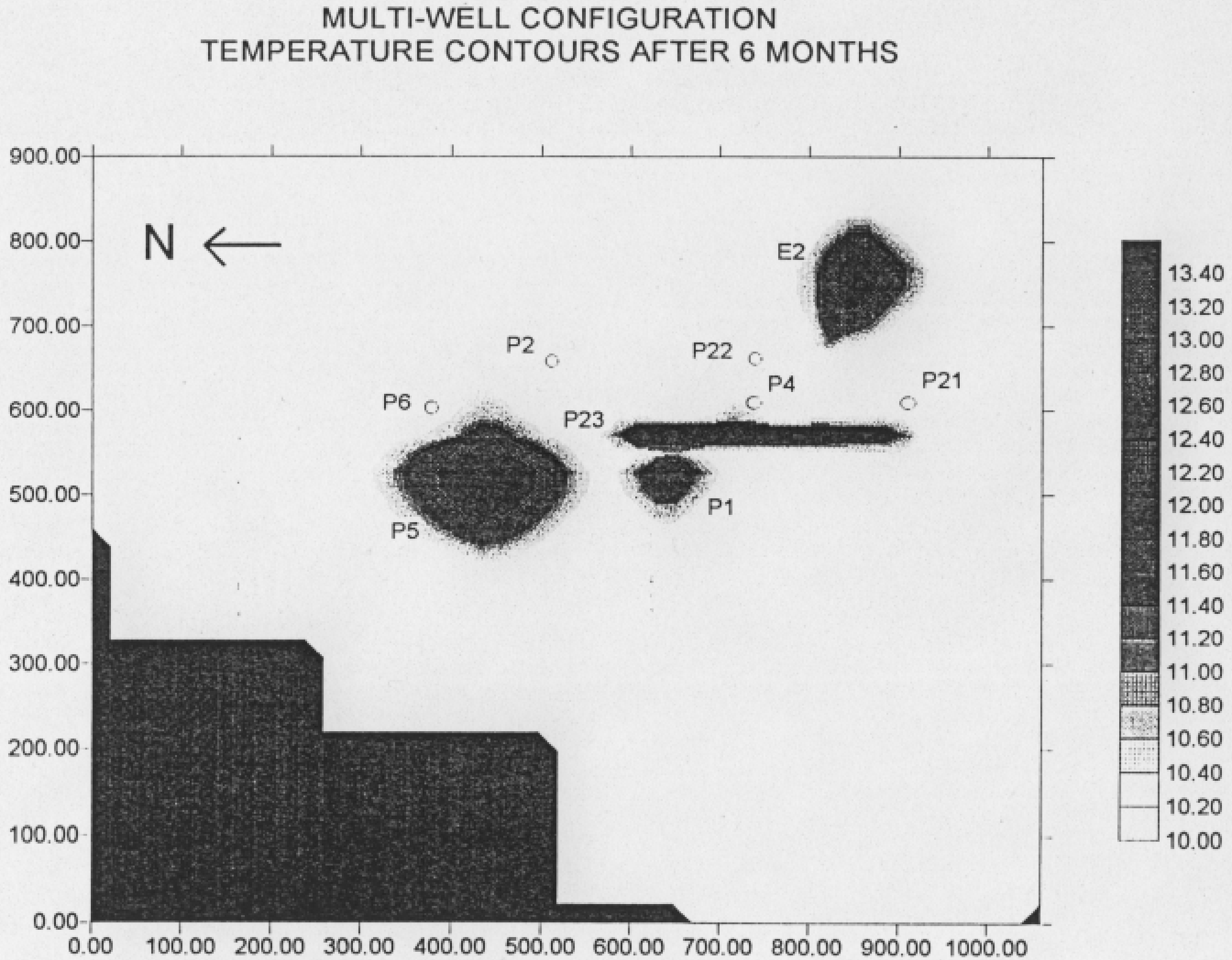


Figure 8.11c: Contour Map of Temperatures at the End of 6 Months for the Multi-well Configuration (CESI, 1994). Total Production Rate is 265 L/s. Aquifer Thickness 6 Metres.

Environmental Benefits

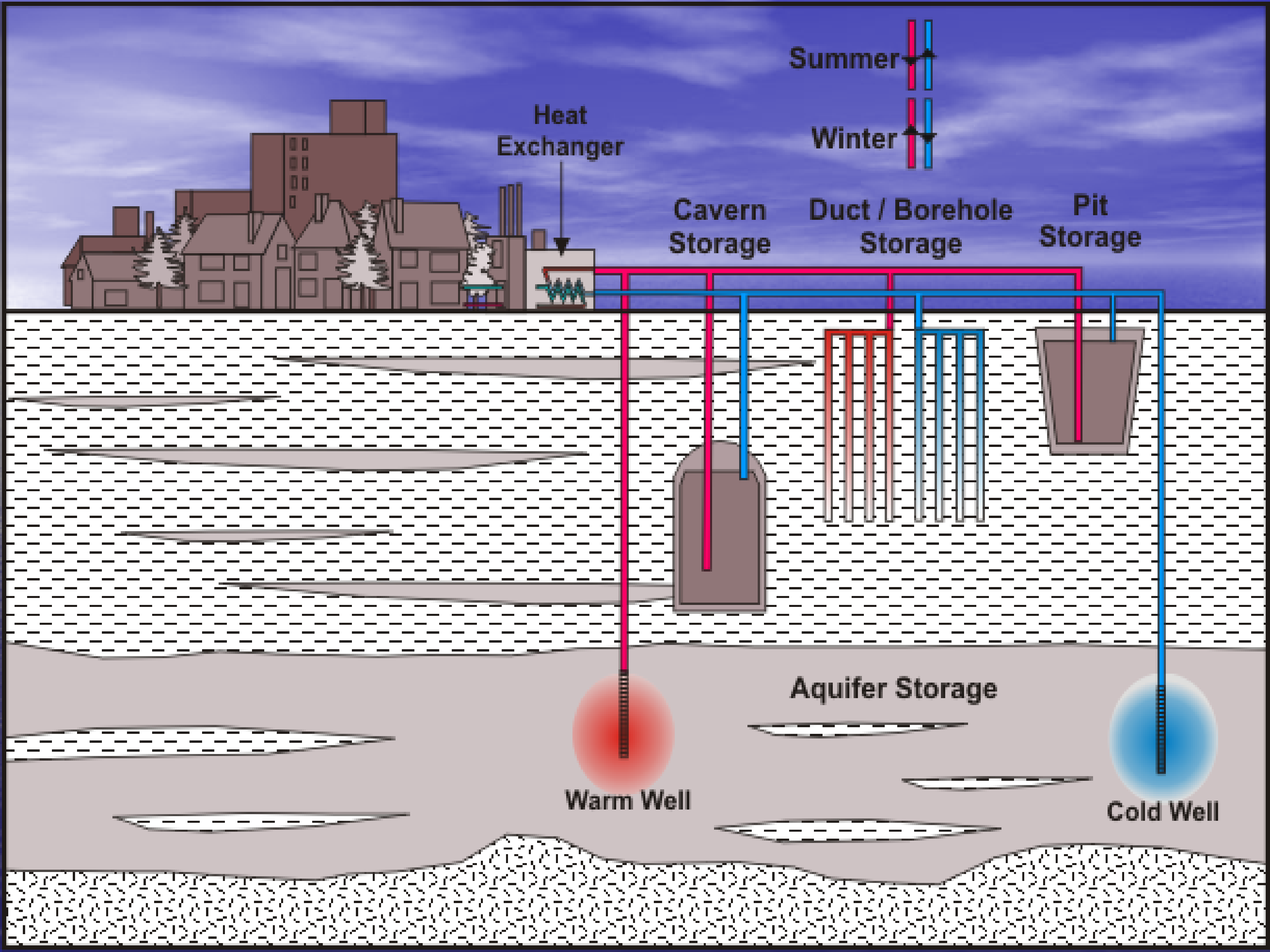
- A reduction in the consumption of natural gas and electricity
- Lower CO2, sulphur and nitrogen compound emissions
- No CFCs
- Renewable resource
- Lower municipal water use
- No cooling towers or chemicals
- Non-toxic to plants and animals

Other Benefits

- Lower operating costs
- Less sensitive to energy price variations
- Can off load from peak demand periods
- Adaptable/hybrids
- Higher efficiencies

Cons

- Up front capital costs
- Unfamiliar newer technology
- Well and pump maintenance
- Interference with other water users
- Requires knowledge of subsurface geology and groundwater flow/chemistry
- Space (land) + an aquifer
- Regulations
- Need to know baseline conditions



Summer
Winter
Heat Exchanger
Cavern Storage
Duct / Borehole Storage
Pit Storage
Aquifer Storage
Warm Well
Cold Well

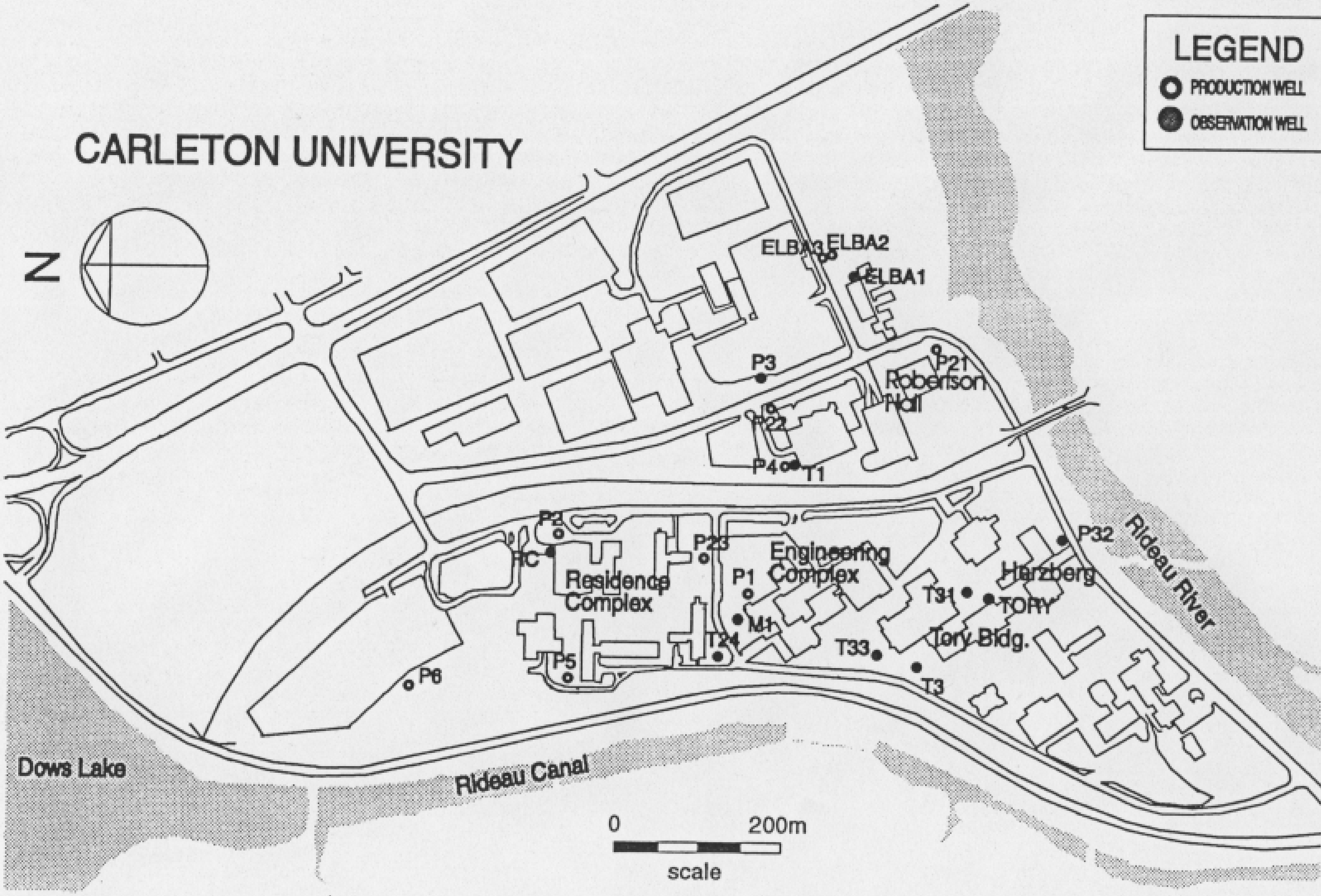
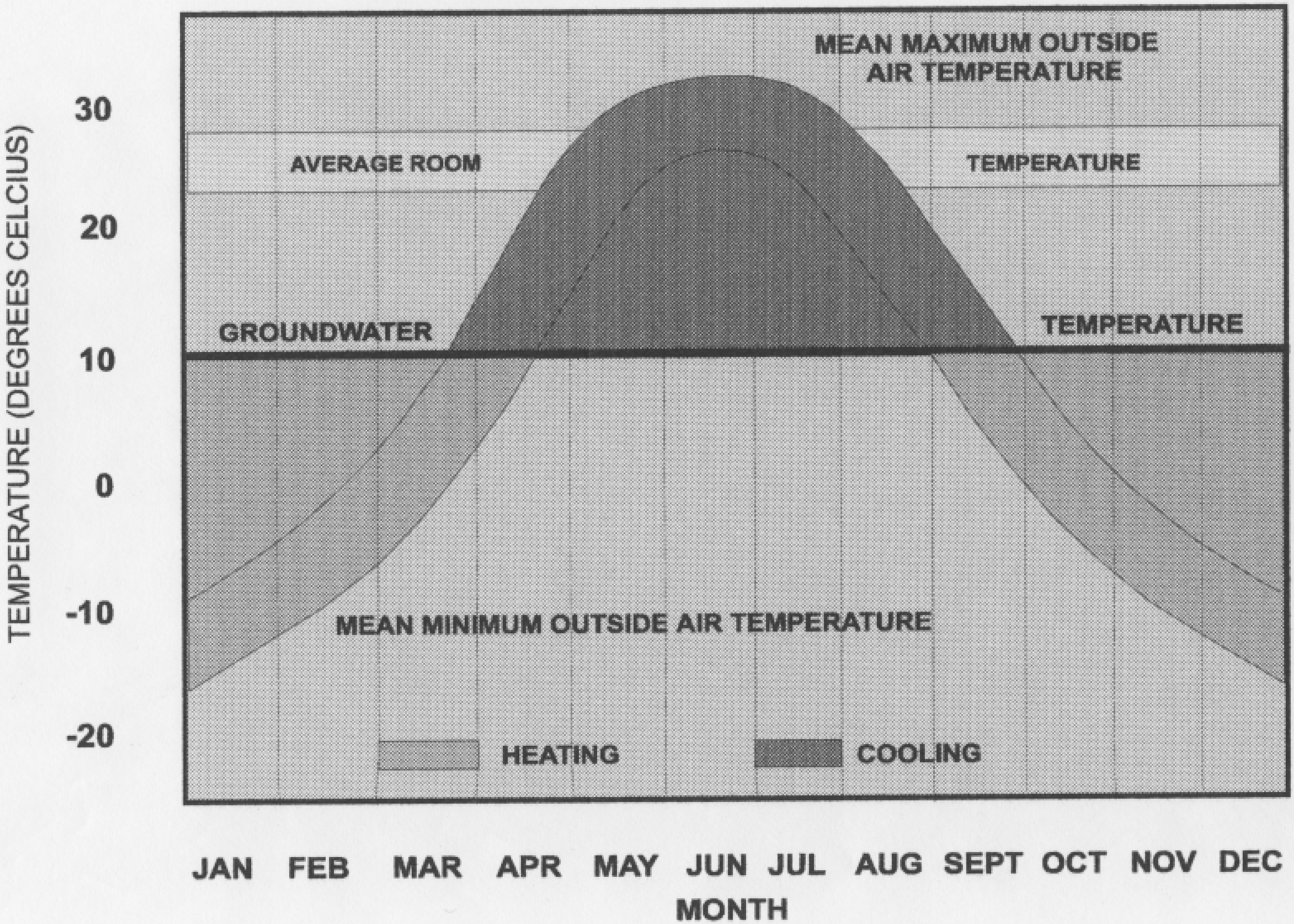
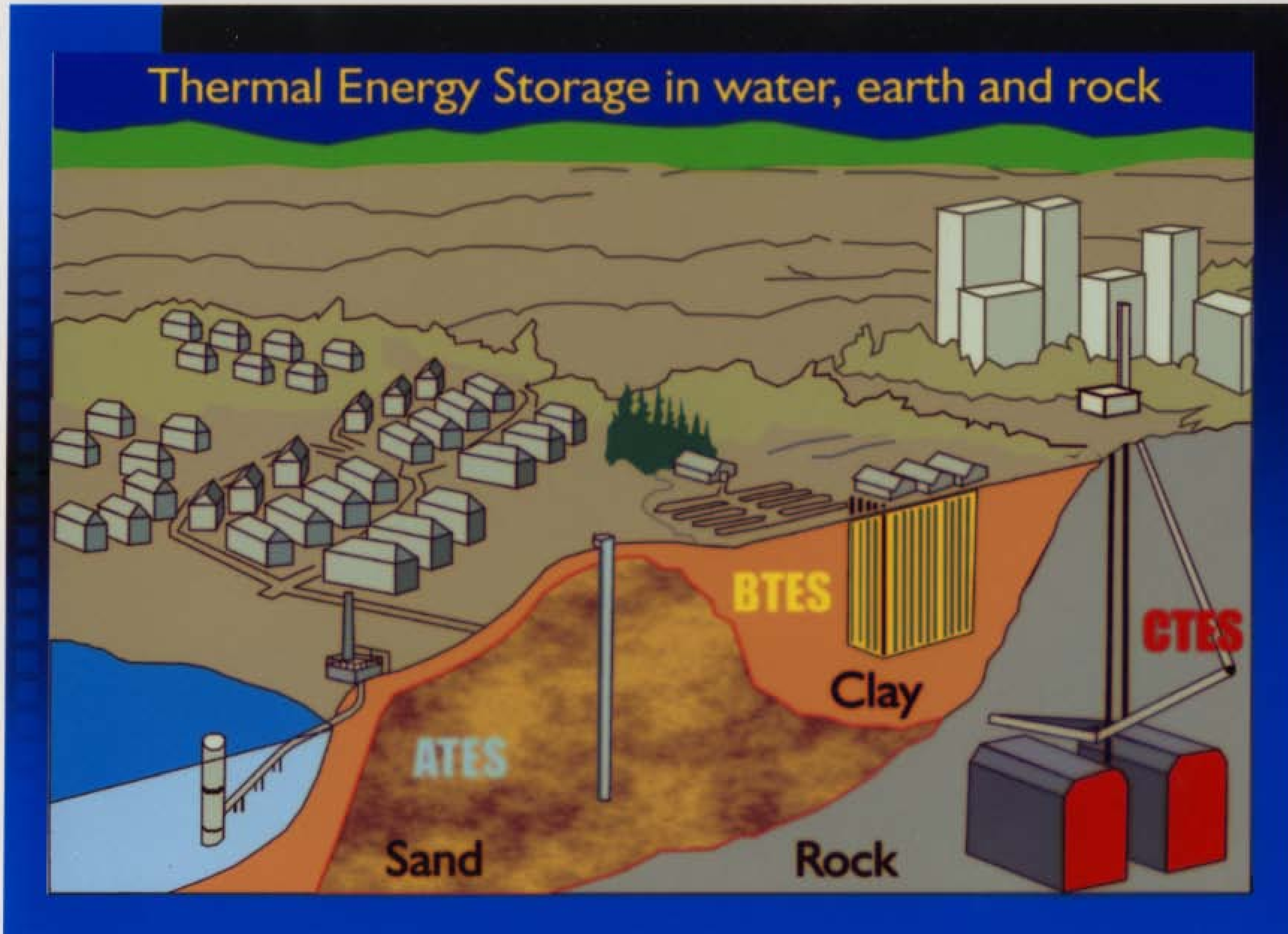
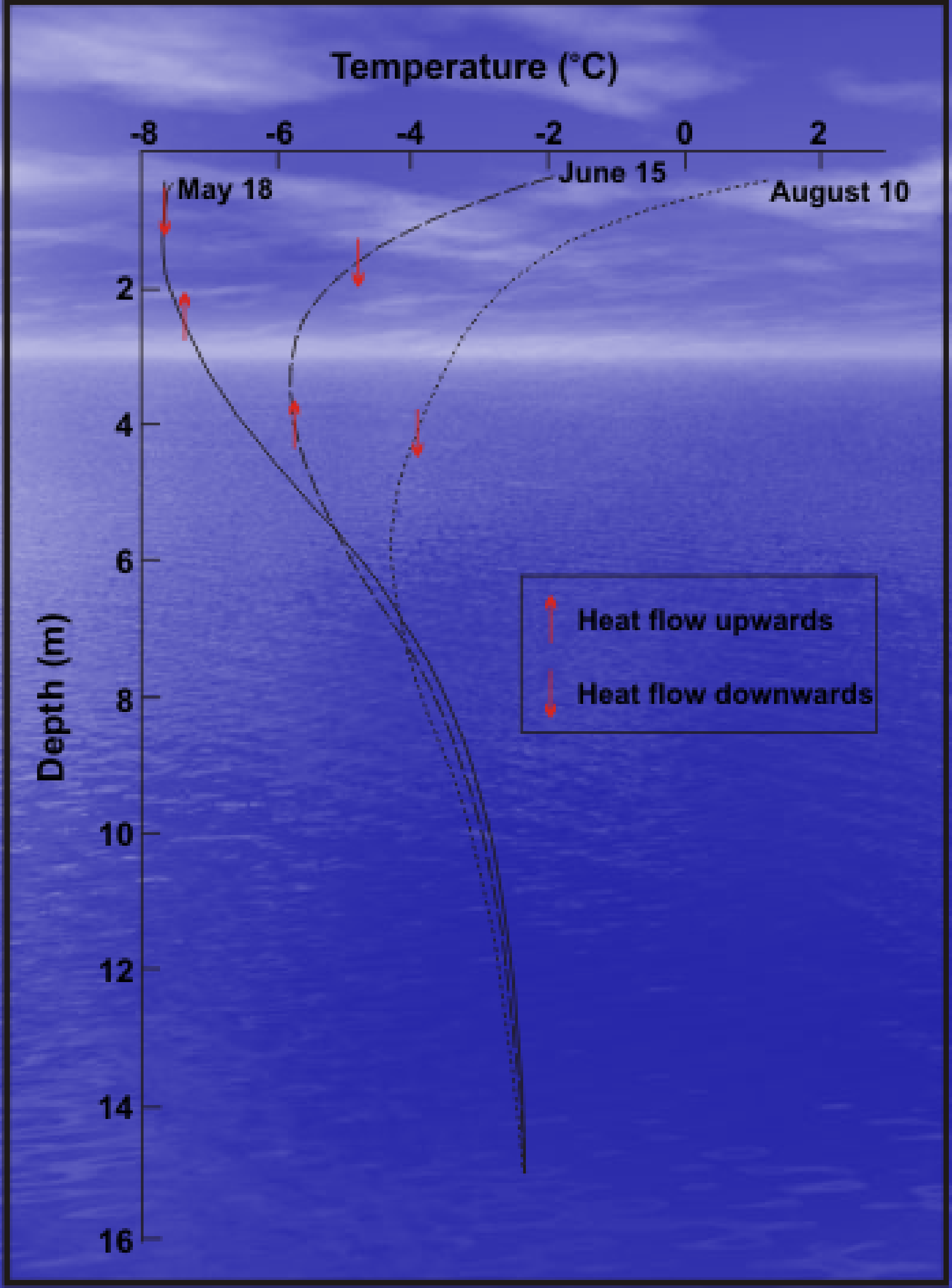


Figure 3.2: Map Showing the Location of Test-and Production Wells on Campus

GROUNDWATER SITE POTENTIAL FOR OTTAWA




Thermal Energy Storage in water, earth and rock
BTES
CTES
Clay
ATES
Sand
Rock



Temperature (°C)
-8
-6
-4
-2
0
2
May 18
June 15
August 10
Depth (m)
2
4
6
8
10
12
14
16
Heat flow upwards
Heat flow downwards