Rotorua Hospital Geothermal System

Graeme Wilson

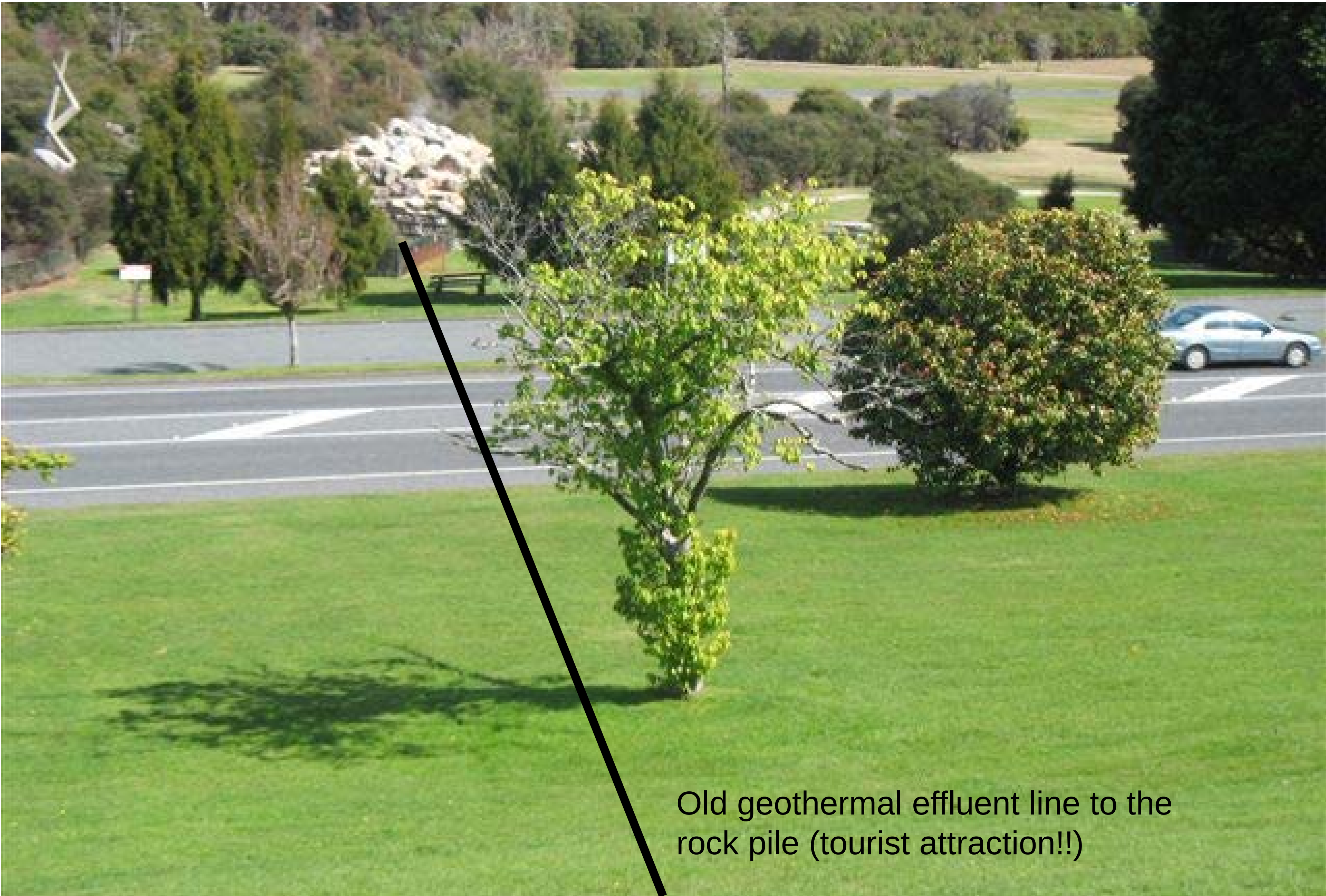
Occupation: Hospital Engineer

Work History: I retired nearly 4 years ago after 50 years in the Electrical and Heating and Ventilating industry in Wellington and later Rotorua. Before retirement I served 25 years at Rotorua Hospital – initially (1983) in charge of Electrical and subsequently (1995) in charge of both Mechanical / Geothermal, and Electrical maintenance prior to my retirement in 2008.

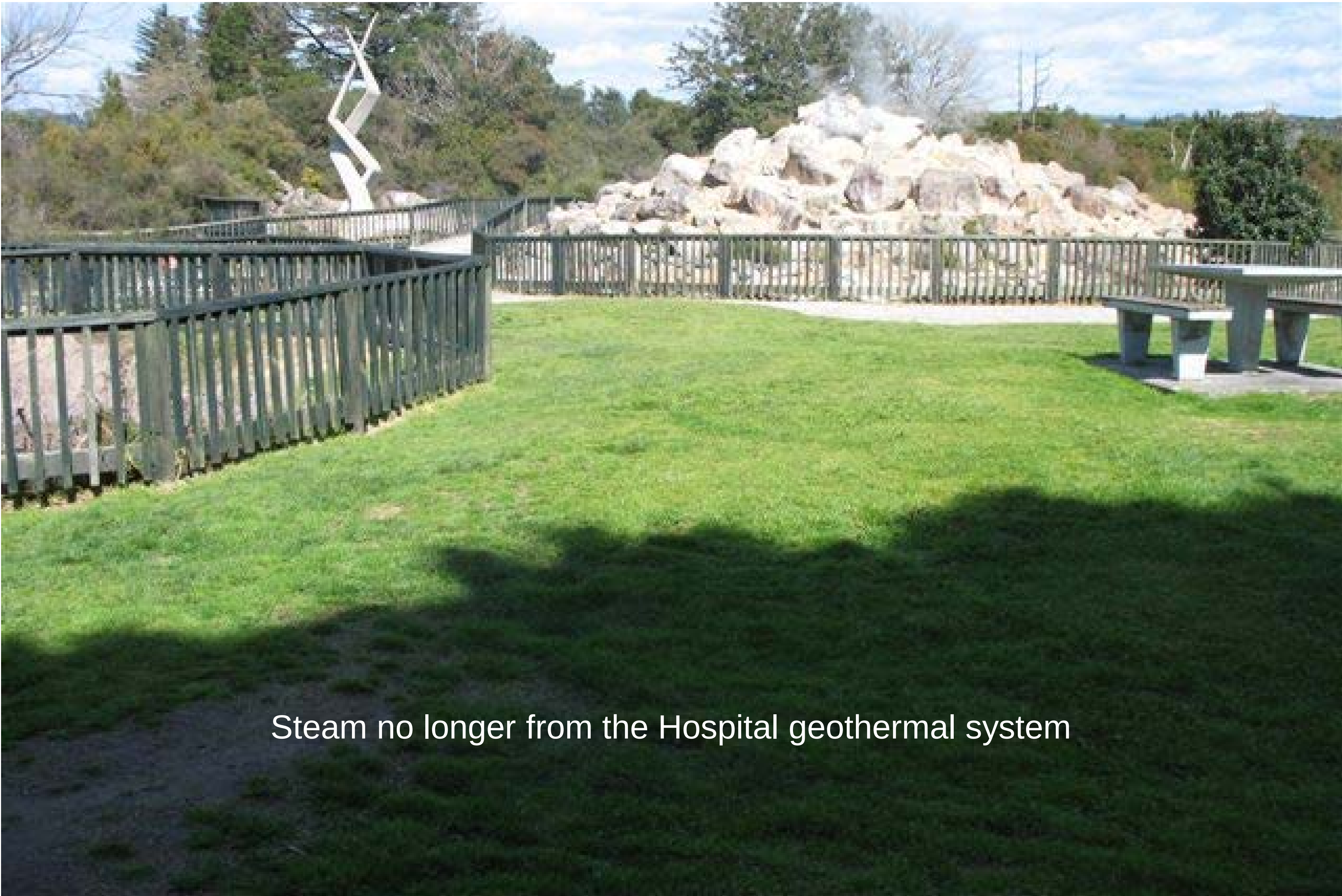
I still work part time at the moment, to assist with the new building development at Rotorua Hospital.

All of which means I'm old enough to remember Pounds Shillings and Pence, Ready Reckoners, slide rules and paying for things with cash.

Hospital hill looking to Kuirau park



Rock pile Kuirau Park

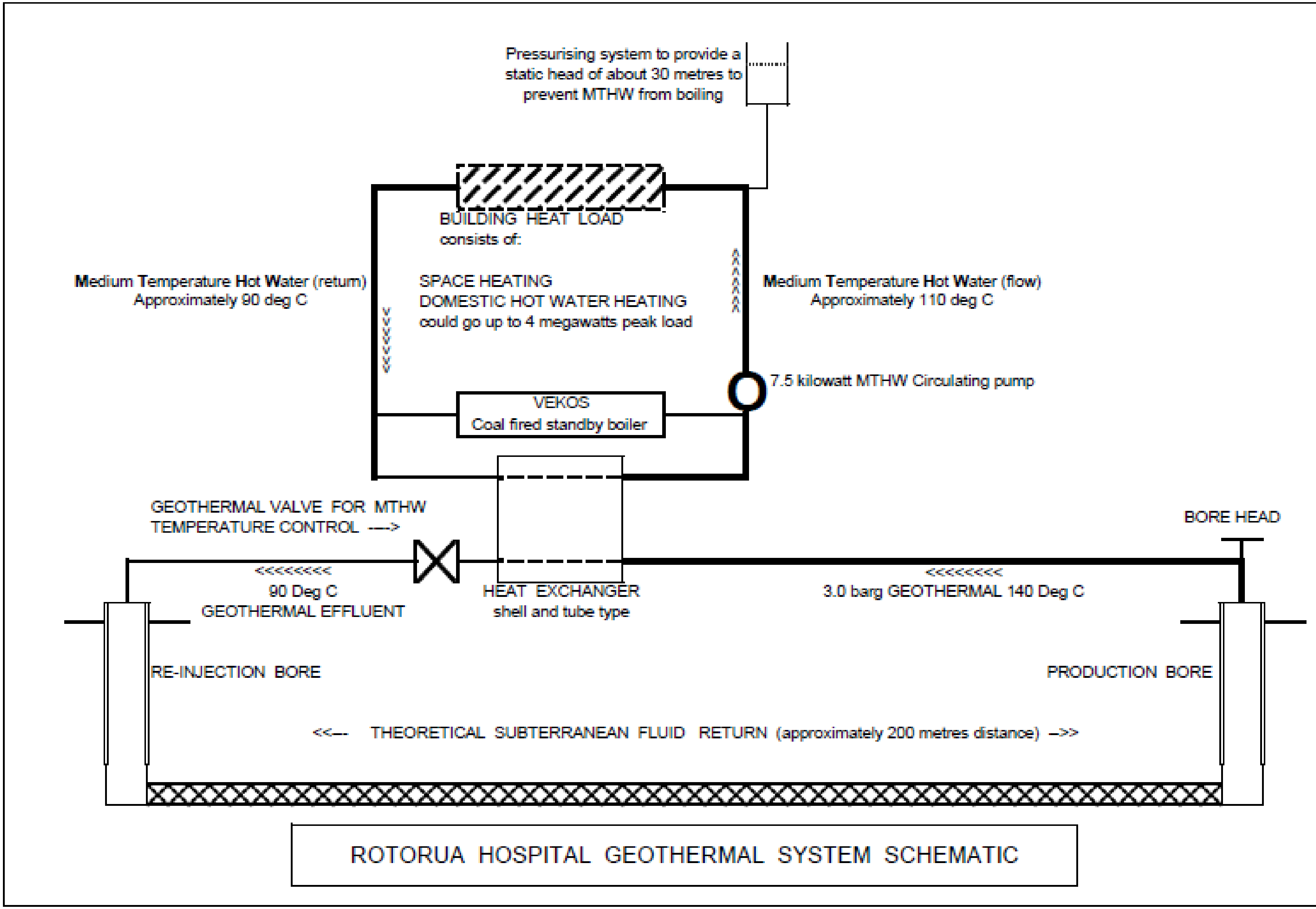


Aerial view of the Hospital grounds

Total Floor area 29,000 sq mtrs, production & reinjection borefields. New Inpatient Building (NIB)

Rotorua Hospital Geothermal Schematic

The process of extraction and reinjection, then heat transfer to a MTHW circulation system



Vekos coal fired boiler for alternative heat source.

Rated at 15,000,000 BTU per hour but about 3 MW on our coal. Barely able to cope with the winter of 1987 bore closure period. The closure period proved that geothermal saved about $500k P.A. at that time in coal costs.

Medium **T**emperature **H**ot **W**ater

What is it?

It is water that is heated to over 100 degrees C (110 degrees at the Hospital), but pressurized to above atmospheric pressure to stop it boiling and becoming steam.
For this reason it is sometimes referred to as **M**edium **P**ressure Hot **W**ater.

It is used for “transporting” heat energy, usually over longer than normal distances, and because of its high temperature requires less water volume and therefore smaller pipes and pumps to transport, than Low Temperature Hot Water would.

Water at about 80°C and below is referred to as Low temperature hot water.
It is commonly used directly for space heating, water heating, etc.

The Hospital uses geothermal energy for Space heating and Domestic Hot water heating.

Why does the Hospital use MTHW?

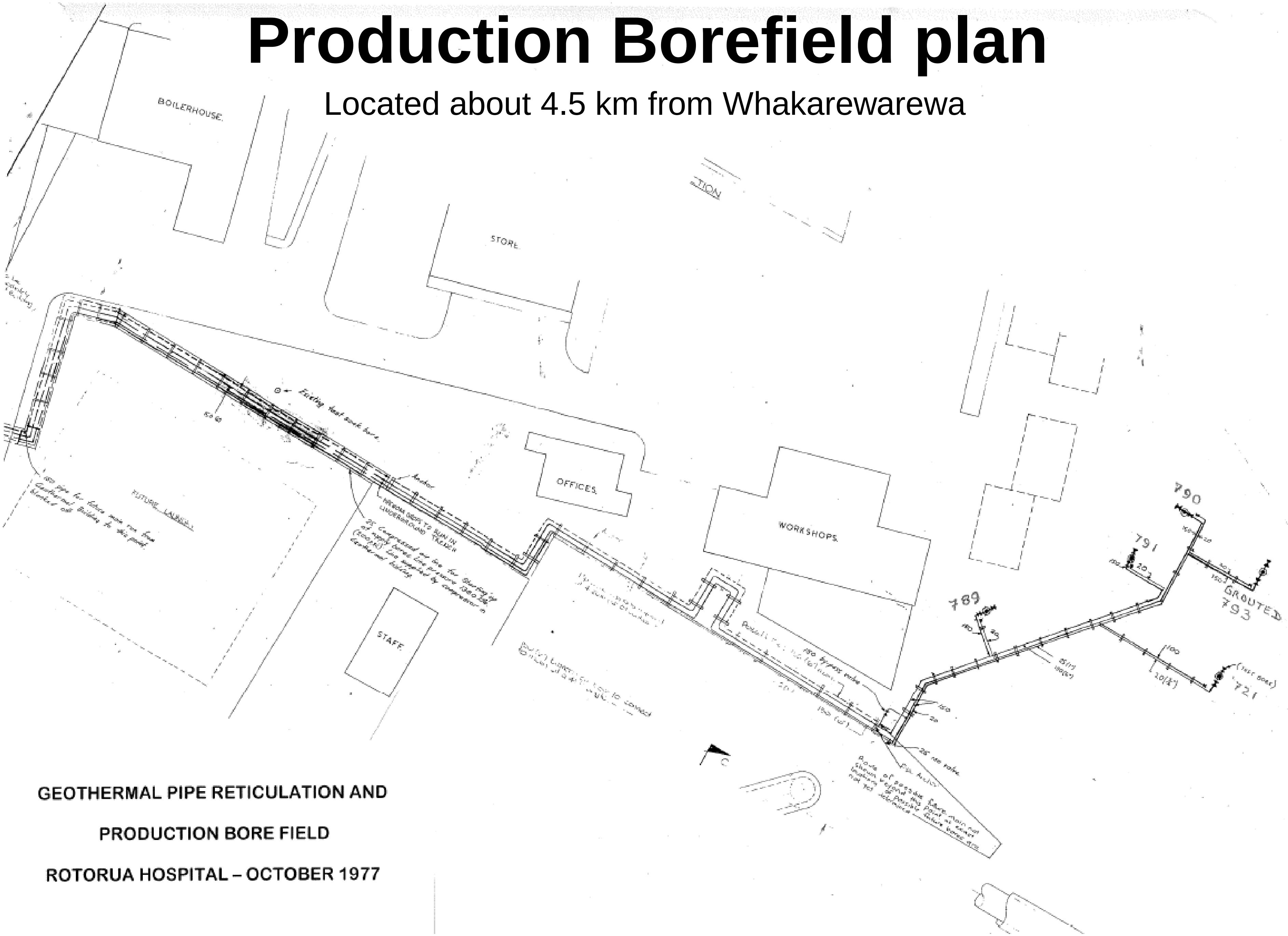
Geothermal energy in Rotorua can’t be used in or near occupied buildings due to its toxic gas levels (Hydrogen Sulphide) content.
Geothermal bores can be quite some distance from the building requiring heat. Geothermal fluid also damages air conditioning devices using metals such as copper or brass in heating coils and control valves.

So

The **<u>heat</u>** from the geothermal fluid is transferred via heat exchanger, into a fresh water system (the MTHW) and reticulated around the various Hospital buildings without any chemical health risk.

Production Borefield plan

Located about 4.5 km from Whakarewarewa



Production Bore field

Note 2 pipes. Allows 2 bores to be used simultaneously.
(We have never used this).

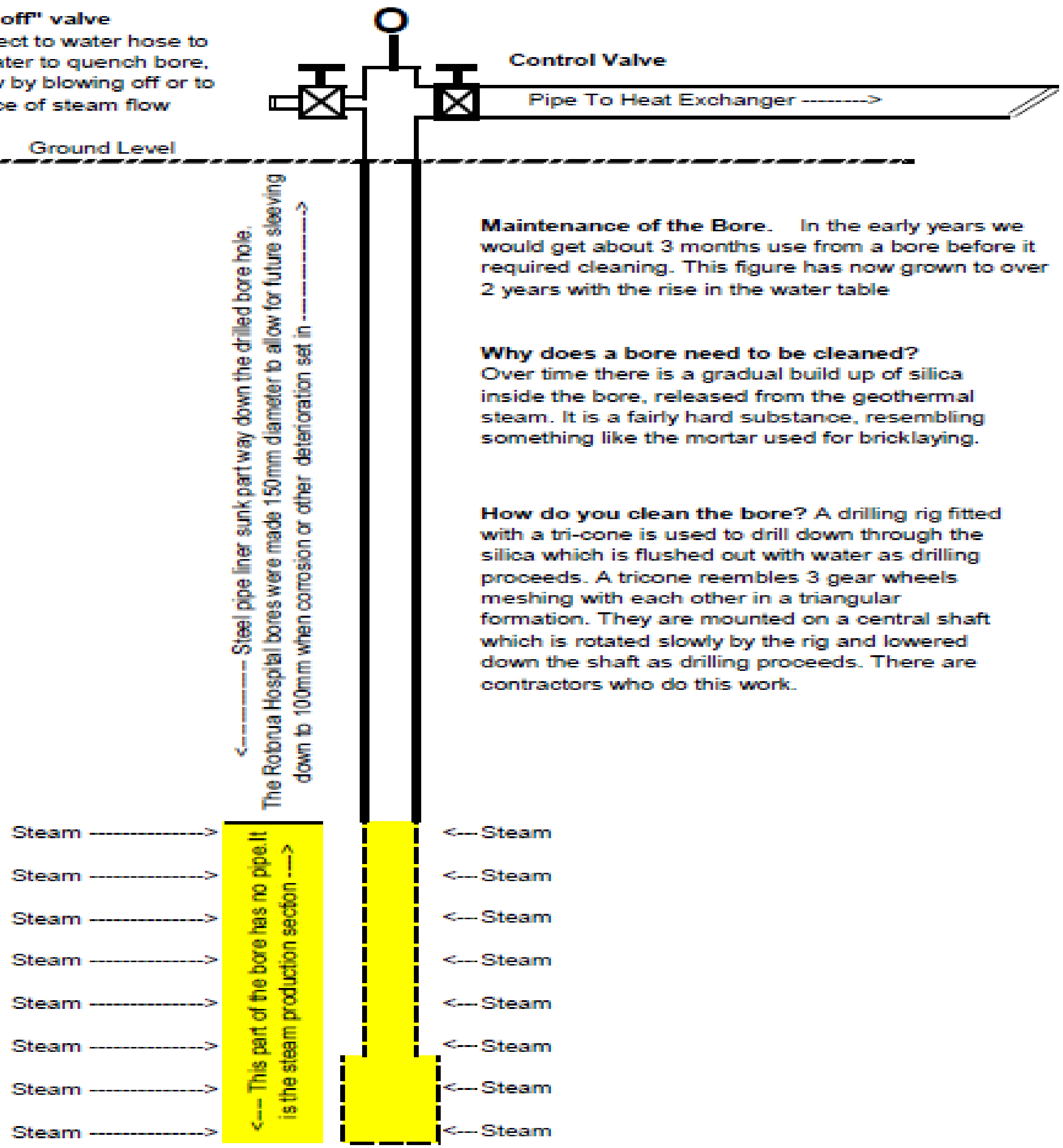
Bore Head

Main taper plug valve and blow off valve also used for compressed air restart.

A Typical Rotorua Geothermal Bore

Pressure Gauge
To start the bore after a shut down, the gauge is removed and a compressed air hose is inserted down the bore to blow out the "slug" of water to start the steam flow.

"Blow - off" valve
It is used to connect to water hose to flood bore with water to quench bore, or start steam flow by blowing off or to prove presence of steam flow



Maintenance of the Bore. In the early years we would get about 3 months use from a bore before it required cleaning. This figure has now grown to over 2 years with the rise in the water table

Why does a bore need to be cleaned?
Over time there is a gradual build up of silica inside the bore, released from the geothermal steam. It is a fairly hard substance, resembling something like the mortar used for bricklaying.

How do you clean the bore? A drilling rig fitted with a tri-cone is used to drill down through the silica which is flushed out with water as drilling proceeds. A tricone reembles 3 gear wheels meshing with each other in a triangular formation. They are mounted on a central shaft which is rotated slowly by the rig and lowered down the shaft as drilling proceeds. There are contractors who do this work.

Bore details. Production & reinjection

PRODUCTION BORES				
Bore No.	Max Temperature (At time of inspection)	Bore Head & Valve Diameter	Depth - metres	Comments
RR 721	135 Deg C	100 mm	**175**	Test bore. Note depth and diameter differ from others.
RR 789	141 Deg C	150 mm	**74**	
RR 790	152 Deg C	150 mm	**84**	
RR 791	126 Deg C	150 mm	**93**	
RR 793	152 Deg C	150 mm	**84**	Would throw up rocks - finally grouted up after tractor accidently ran into it!!!
RE-INJECTION BORES				
RR 1008	126 Deg C	150 mm	**144**	
RR 1009	158 Deg C	150 mm	**75**	
RR 1010	190 Deg C	100 mm	**78**	
Consented Maximum Daily Fluid Draw - Off		**620 tonnes**		

Geothermal Fluid Consumption

Date	Year	MW / Day	Cubic Mtrs / Day	Typical Bore Life : Days	Bore No.
September	2010	32.4	403	252 to 300	791
October	2010	28.7	361		
November	2010	21.1	253		
December	2010	18.7	224		
January	2011	23.5	223		
February	2011	17.2	195	197 to 210	789
March	2011	16.8	221		
April	2011	26.2	311		
May	2011	29.4	340		
June	2011	29.6	347		
July	2011	41.2	473		
August	2011	38	498	49 to date	791
September	2011	38.6	454		

Heat exchangers – building

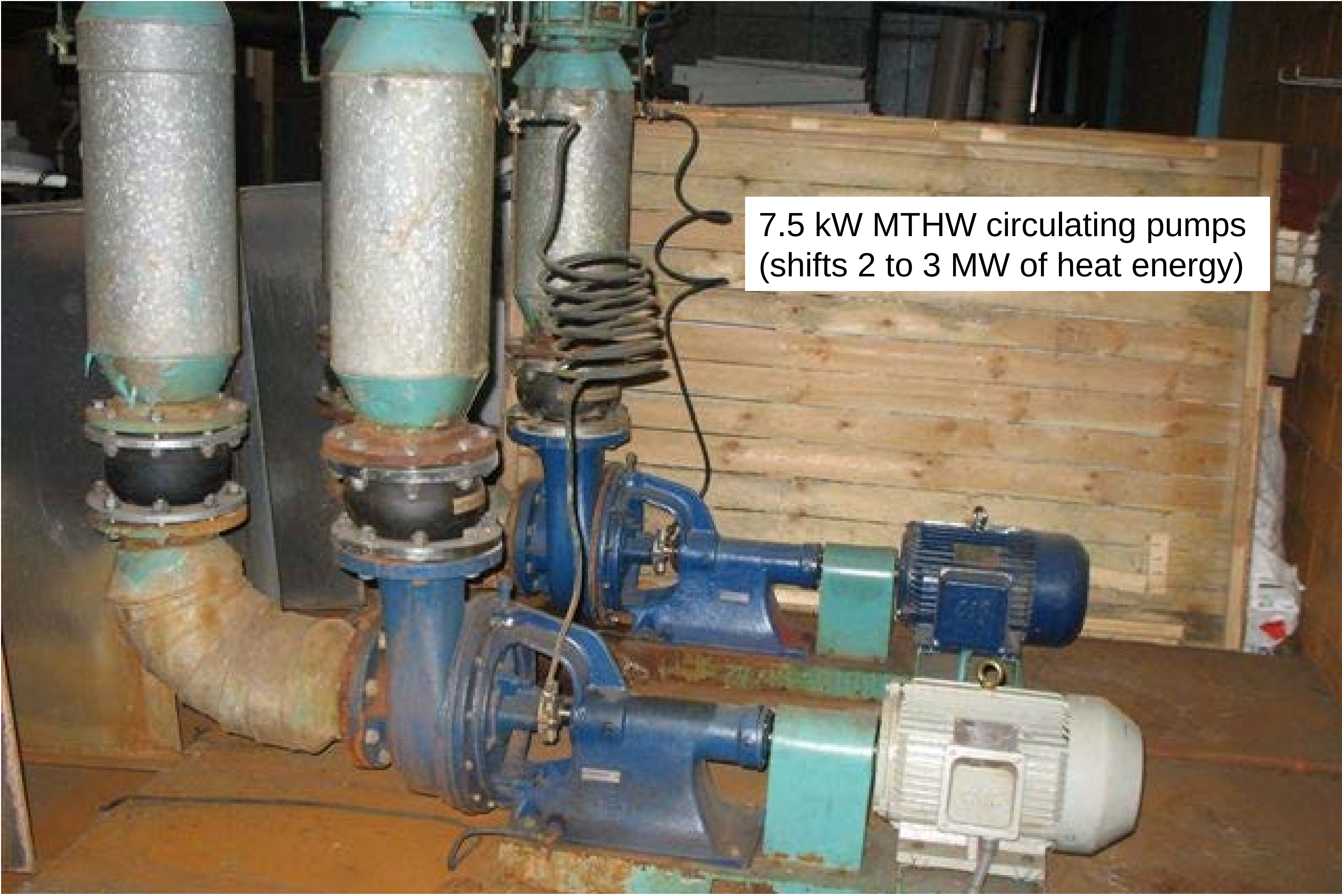
2 sets of 3 heat exchangers.
We could run 2 bores at once,
but have never needed to do so.

Heat exchanger view of shell & tubes

Note the 6 shell & tube exchangers
per enclosure. Each one is 6 metres long.
Maintenance free compared with plate
type heat exchanger.

Geothermal control valve

Orange valve controls fluid flow to reinjection. Opens in response to call for heat from MTHW



MTHW circulating pumps

Geothermal system control panel

Monitors heat, provides power to controls & pumps.

Reinjection bore field

Total of 3 bores. They are approximately 200 metres away from the producer bores

½ megawatt transformer

If the heating was electrical energy, 5 or 6 of these transformers would be needed.

HEAT LOADING

Several monthly heat load charts follow for summer and winter of 1992 and 2011.

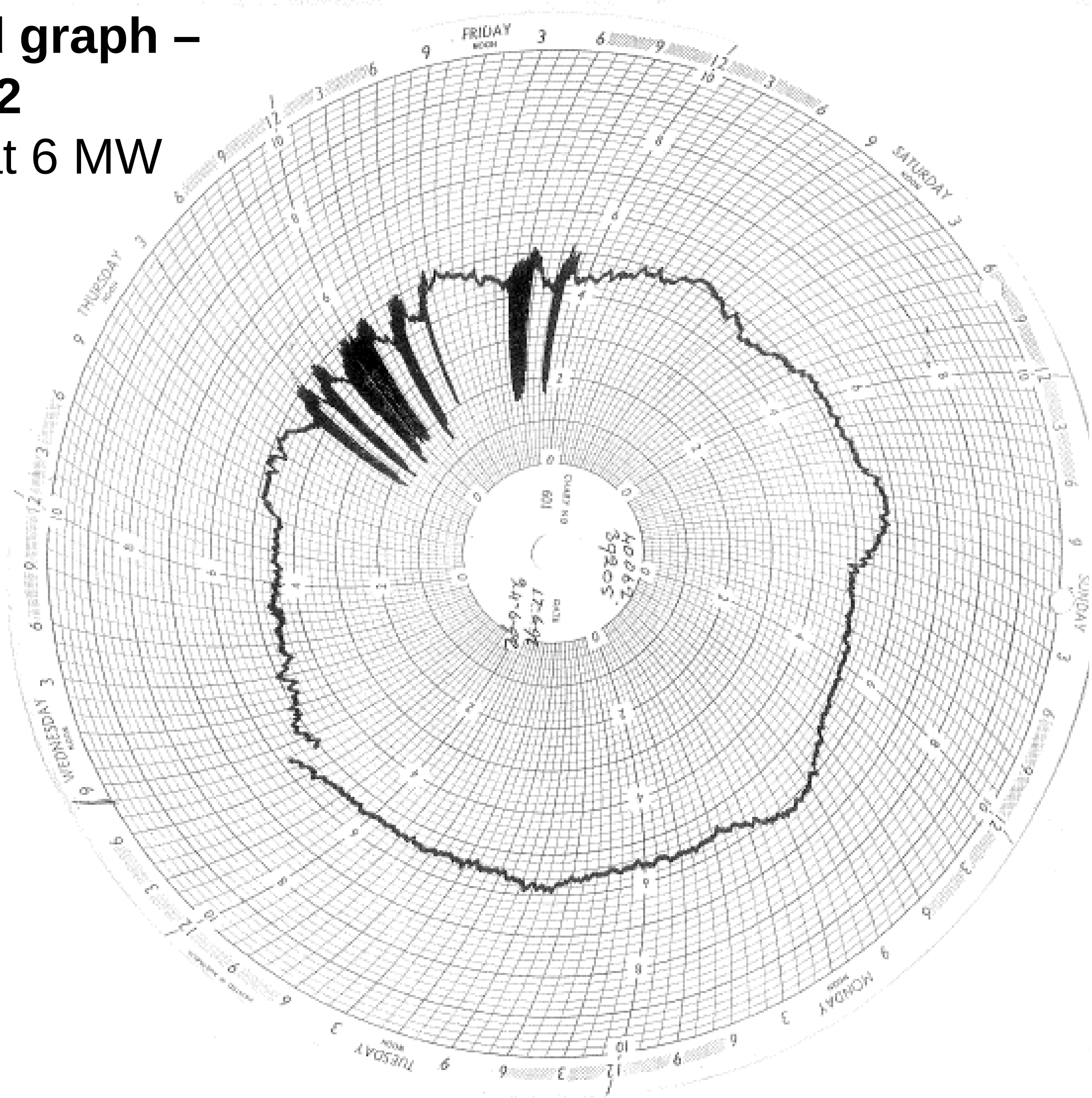
These identify the change in heat load:

- Between seasons
- As building insulation has improved
- Over time
- The change in clinical philosophy – It is no longer necessary to "Throw away" 100% of the supplied air. A 20% fresh mixed with 80% used but filtered is OK for many areas. Even sensitive areas such as Operating Theatres can often tolerate 40% fresh mixed with 60% filtered used air.
- There is an old adage "Bugs don't fly, they hitchhike". Meaning if the air has no particulate matter in it (eg dust, aerosols etc) bugs can't travel.

This has lowered the demand for energy not only for heating in Winter but also for cooling in Summer. We are now being "kinder" to Mother Nature.

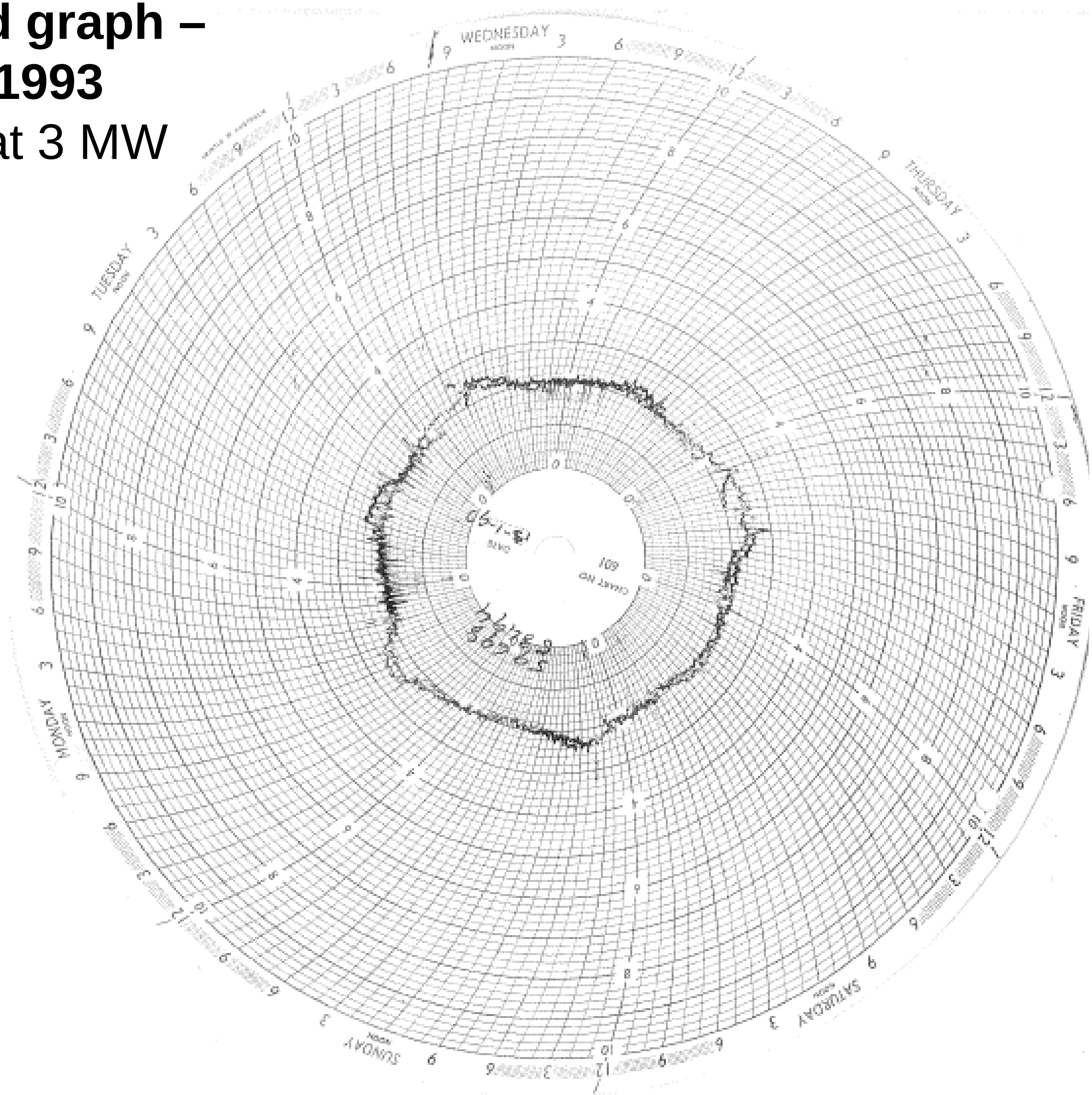
Heat load graph – June 1992

Peaking at 6 MW



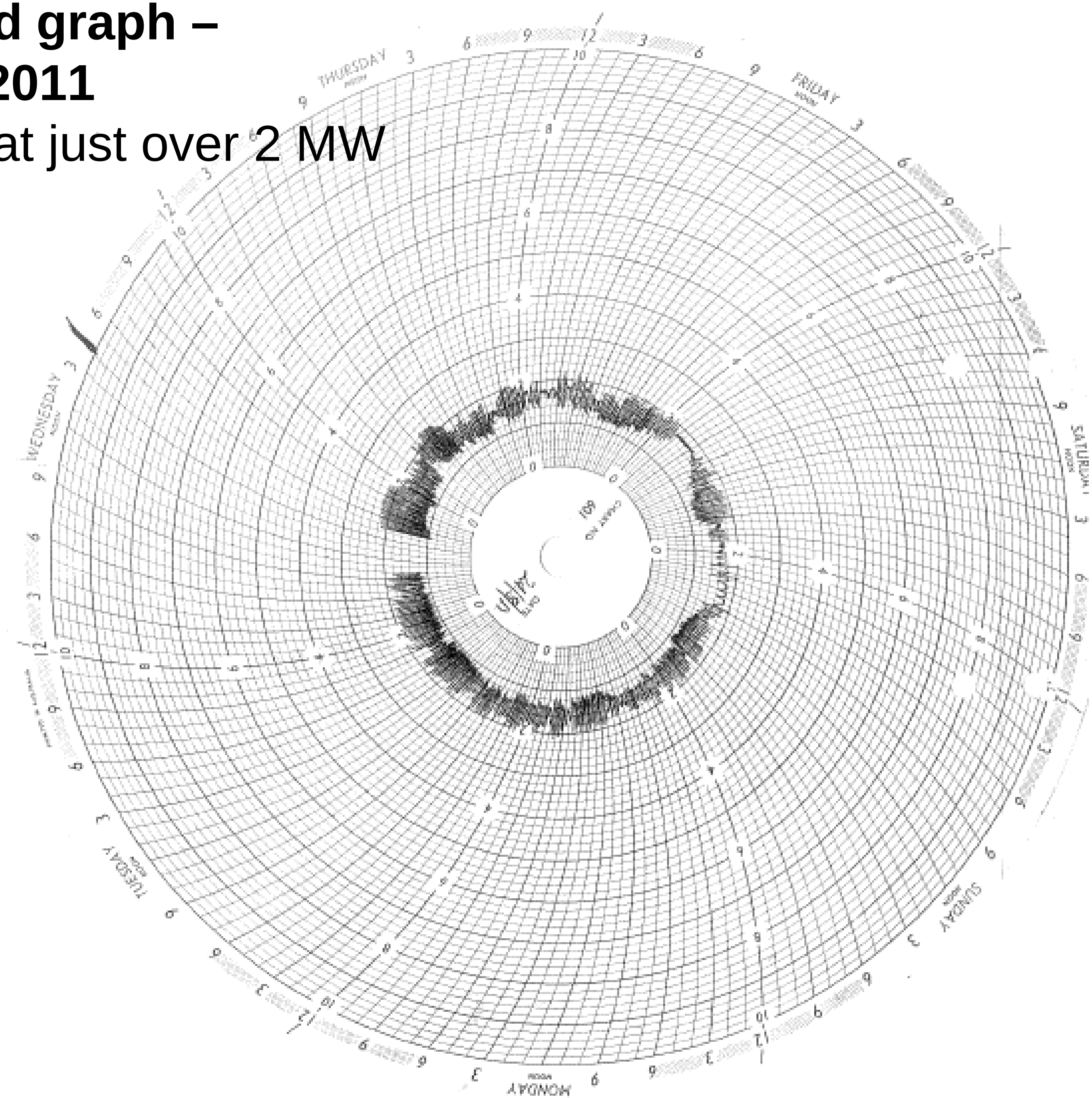
Heat load graph – January 1993

Peaking at 3 MW



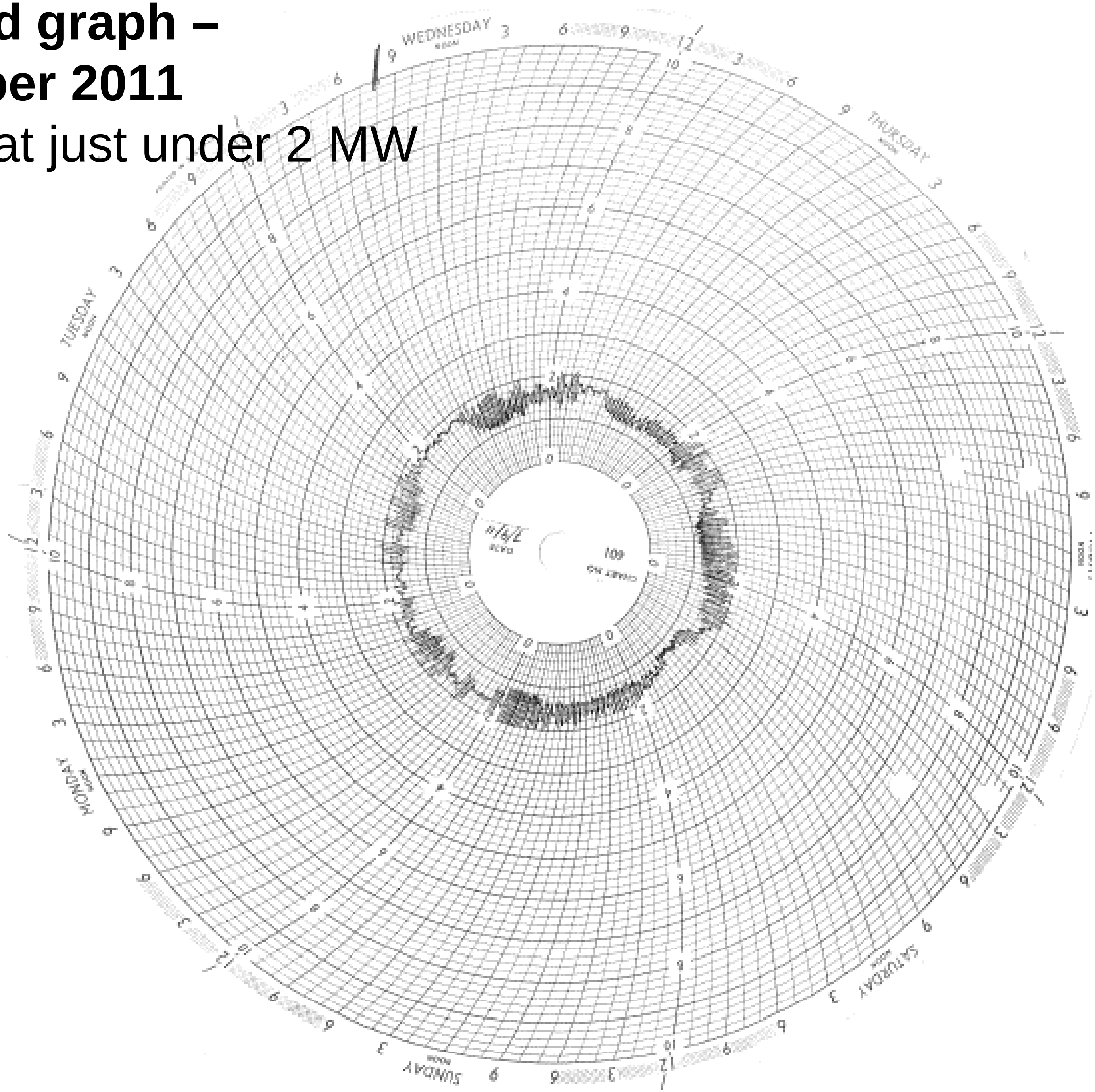
Heat load graph –
August 2011

Peaking at just over 2 MW



Heat load graph – September 2011

Peaking at just under 2 MW



Finally

Could geothermal be used for cooling using absorption chillers?

2 studies we have done indicated yes.

Using geothermal for cooling in the summer period would make use of the low geothermal production thus avoiding overheating the reinjection bores.

However, the extreme variation in load for our air conditioning made its viability doubtful because mechanical chilling would be needed to smooth the load.