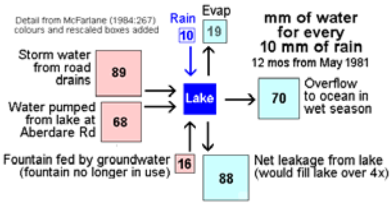
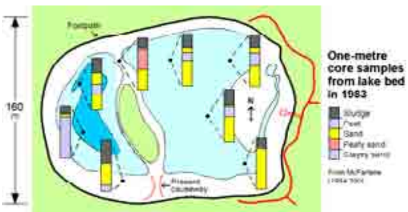
The secret life of water in Lake Jualbup Summary

An illustrated digest of the available scientific information by Geoffrey Dean PhD DIC BSc ARCS, a local resident for over 20 years and formerly with the Soil Bureau Wellington NZ, and CSIRO Soils Division, Perth. August 2010, this website version February 2012.
Page 1 briefly steps through 37 pages of background information. Pages 2-4 step through 16 pages of predicting lake levels.

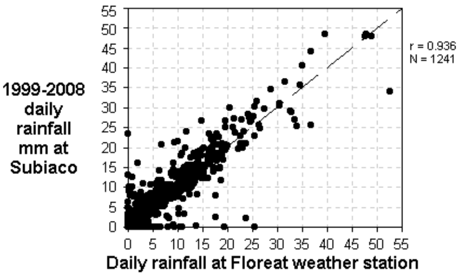


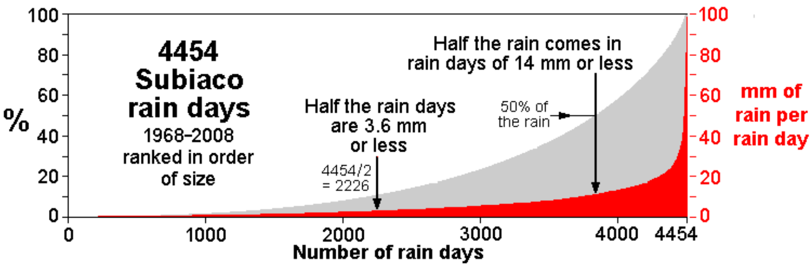
A **summary of previous studies** including a PhD thesis and a BSc dissertation, which together measure almost everything that could conceivably be measured including the water lost by trees. A **summary of reports** commissioned by the City of Subiaco at a cost of $111,580.00, the essence of 330 pages distilled into three:

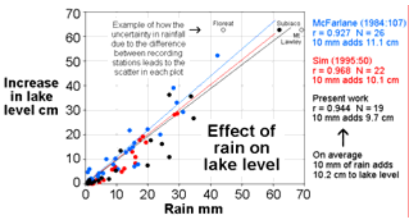
Plus five new theses and reports, a look at Hyde Park Lakes, the March hailstorm and its effect.



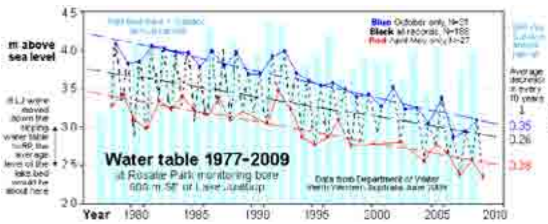
Lake dimensions including volume vs area, length of footpath (700 m), contours of lake bed, composition of lake bed via core samples. **Catchment area,** pipes in and out, pumpage from Aberdare Road and its volume. **Rainfall**, its variability over the years (average annual decrease in Shenton Park 1958-2008 is just 0.03%), and its astonishing variation between rain gauges.

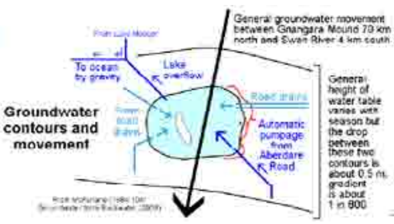


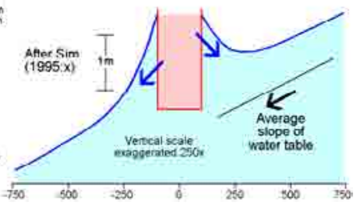


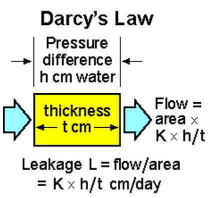


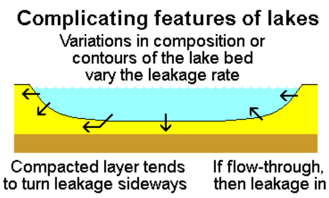
Evaporation depends on weather (1 to 8 mm a day), effect of vegetation, measured losses due to trees including willows are negligible. **Effect of rain on water level,** three studies including mine agree that on average 10 mm of rain raises level by 10 cm, or 20 cm if pumpage is included. **Water table** levels 1977-2008, groundwater flow, leakage of groundwater in and out of lake..





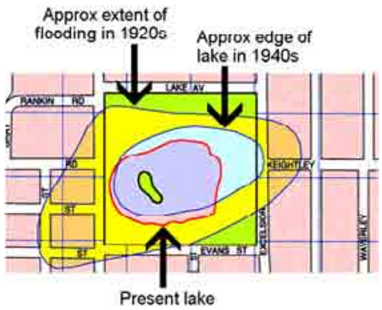






Predicting lake level from rainfall. Theory leads to a way of predicting leakage from lake level (the ratio level today / level yesterday is roughly constant), which when combined with the effect of rainfall allows lake level to be predicted from rainfall for any leakage rate. Now read on.

Two myths about Lake Jualbup

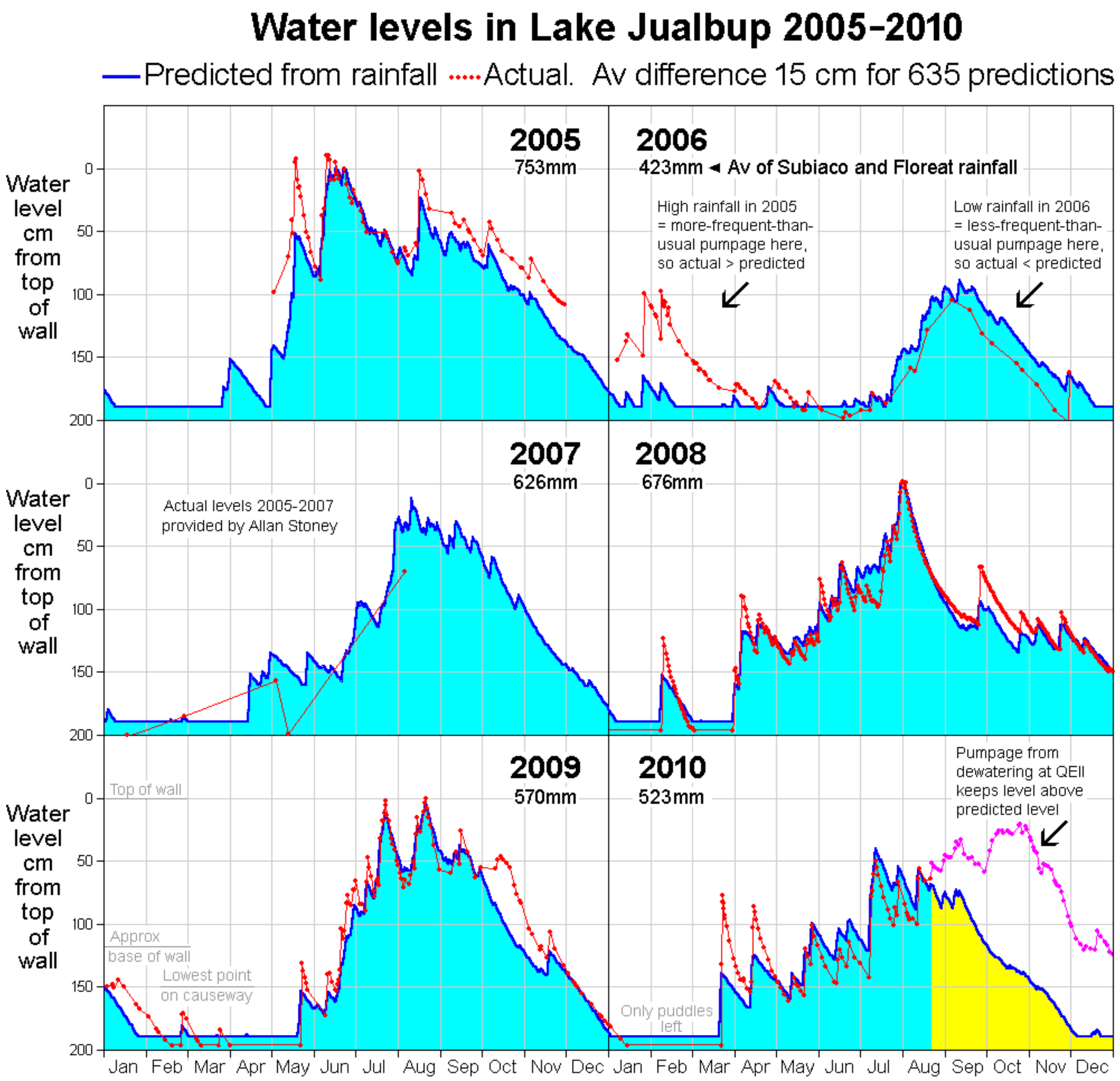


The lake is neither a natural lake nor a natural wetland. Instead it is essentially man made. Until the 1950s the area was used as a rubbish tip. (Already by 1929 the lake area had received many hundreds of tonnes of infill, thousands of cartloads of rubbish, and thousands of old railway sleepers to keep the roads in service after heavy rain.) It was then bulldozed to form the present lake and grassed areas. Today it is a holding pond for road runoff that would otherwise overwhelm the road drains.

The Lake is not short of water. Each year it gets enough from storm runoff (left) and pumpage from Aberdare Rd (right) to fill it around 8 times. It dries up because it leaks like a sieve. Restore the natural seal lost by dredging and the lake could be full year round.

Predicting the effect of rainfall on lake level

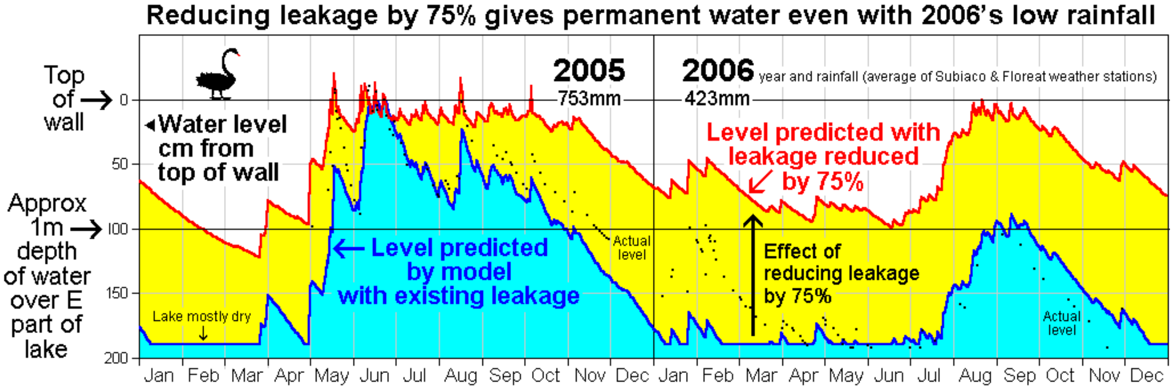
To recap, we can predict the rise in lake level due to rain, and the fall in lake level due to leakage. So if we know the rainfall we should be able to predict lake level. And we can. It works quite well:



Above, the predicted levels (blue) closely match the observed levels (red), the average difference for 635 predictions during 2005-2010 being only 15 cm. And note how the days when the predicted level is at its highest is always close to those observed. But what happens if leakage is reduced? See next.

Predicting the effect of reduced leakage

To predict the effect of reduced leakage, we simply run the calculations for different leakage rates for as many years as we have rainfall data. The results when leakage is reduced by 75% to 25% of the existing rate, for 2005 (a high rainfall year) and 2006 (a low rainfall year) are shown below:



Above, even in 2006, permanent water could be achieved by reducing leakage to 25% of existing. Grey dots show the observed levels (repeated from the previous figure)

Even 25% represents a sizable leakage of more than 0.7 cm per day when the lake is half full. It is about twice the average evaporation and will deliver to the groundwater nearly 200 cubic metres per day, or enough to fill an Olympic-size pool every fortnight. It is considerably more than the average observed leakage of 0.05 cm per day for farm dams in the NE wheatbelt of WA (Luke and Denby 1987:11). It is also more than the leakage from Mundaring Weir in the 1970s, which was up to 0.20 cm per day outwards in summer, and up to 0.04 cm per day inwards in winter, when the water table was respectively lower and higher than the lake level (Hoy & Stephens 1977).

Of the above plots, the year 2005 had the largest number of predicted overflowings. So in 2005 the flooding of the lake surroundings should have been appreciable. And it was, as pictured below,

Above, the southern footpath in June 2005 was under >10 cm of water. It lasted less than a day.

Rockwater (2005:23) suggests that leakage could be reduced by top dressing the lake bed with bentonite, or similar clay product, as routinely used for farm dams. [Synthetic products are available that are cheaper than bentonite and more effective, see *Follow-Up* on this website's home page].

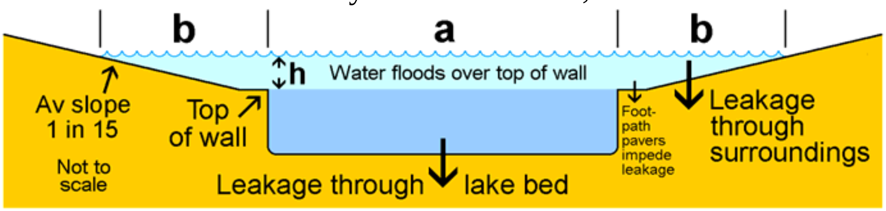
Overflow to ocean vs leakage

The outlet drain to the ocean is in the northwestern part of Lake Jualbup as pictured below.



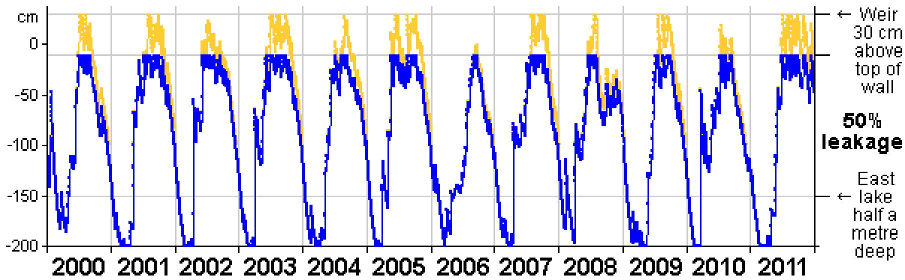
Above left, the outlet drain enclosure juts out from the lake edge. **Middle**, it consists of a weir protected by a grille to prevent leaves entering. **Right,** new grille early 2011, previous calculations no longer apply.

When water is 10 cm deep over the weir it represents a volume above weir level of about 2600 cubic metres, or enough to fill an Olympic-size swimming pool. It is also generally close to, or just over, the footpath around the lake. A reduction in leakage would generally increase the overflow and therefore the amount of water lost to the groundwater. But raising the outlet would help to return to the groundwater all water currently lost to the ocean, as shown below.



Above, as the lake level rises above the top of wall, water floods over the surroundings as shown in pale blue. According to local residents, in the past even severe floods (eg knee deep) never lasted more than three days, which suggests that the outlet drain is less effective at dealing with floods than allowing the same depth to soak naturally into the surroundings.

However, a recent review by Rockwater (January 2012, see this website) points out that local accounts of rapid soakage into the surroundings are incompatible with hydrological estimates, an incompatibility impossible to resolve without direct (and unavailable) measurements of soakage. So as a precaution I re-ran the previous calculations, this time conforming to Rockwater's estimates. As before, it was leakage reduction that kept summer levels high. It also increased the number of floodings, but the right combination of leakage reduction and height of outlet drain still produced useful results (see plot below). An approach in which changes were made step by step would allow all unknowns to be assessed without undue risk (we would see what the lake actually does rather than guess). The changes needed to produce any particular outcome would then be reliably known.



Left, an example from the updated model. The blue plot shows predicted water levels 2000-2011 with the existing weir height and 50% leakage. Reducing the leakage has increased the loss of water over the outlet, but much of this loss can be prevented by raising the outlet 30 cm above top of wall (yellow plot). This of course will lead to floods up to 30 cm deep over the footpath (not an unusual occurrence in the 1970s and 1980s), in which case soakage into the grass is critical in determining how long the flood will last. The new model allows armchair exploration of the effects of rainfall, leakage, soakage, and weir height. As before, it always involves uncertainties, so it should not be taken too far. Nevertheless it illustrates the benefits that come from calculating rather than guessing.

Concluding remarks

Lake Jualbup is a holding pond for road runoff that would otherwise overwhelm the road drains. It receives far more water than a comparable natural lake, most of which is presently lost by leakage. A reduction in leakage would eliminate or greatly reduce the present drying-up in summer, even with continuing falls in the water table. The outlet weir presently discharges surplus water to the ocean, yet may (or may not – it depends on whose report you read) be less effective at dealing with floods than allowing the same depth to soak naturally into the surroundings. But all of these things can be tested in a low-risk step-by-step approach and nothing need be left to speculation. Which should allow the future lake to be whatever the community chooses.