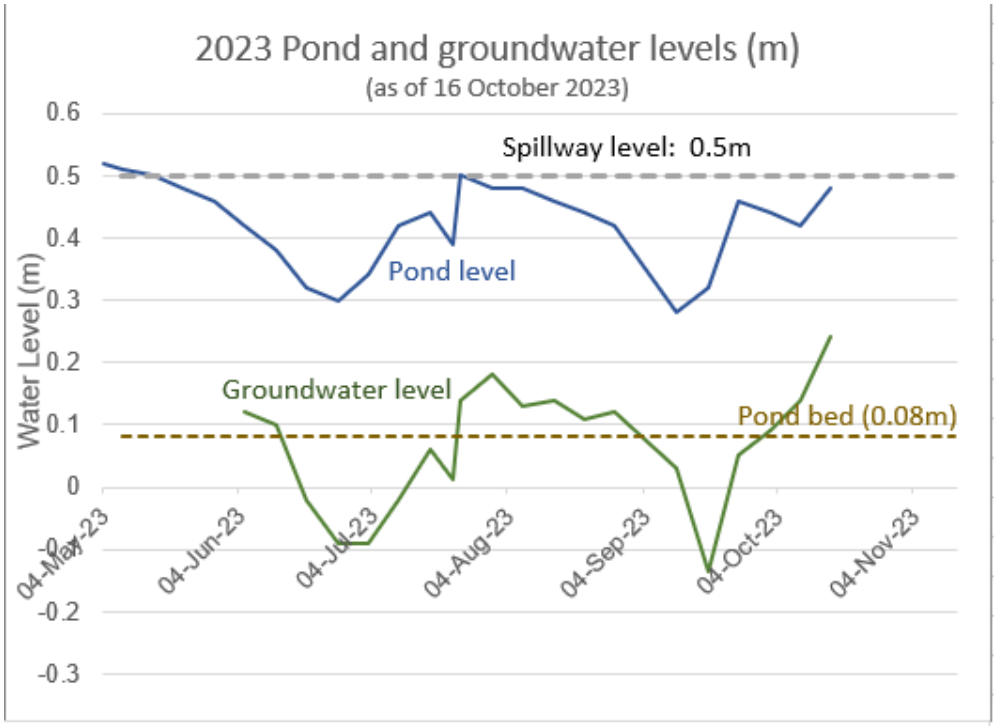
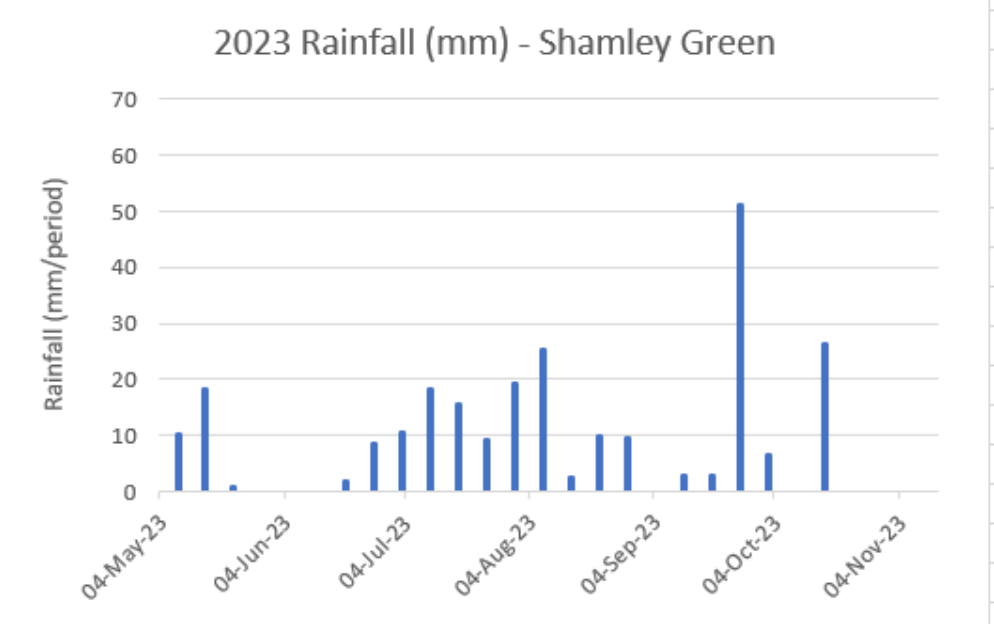
Shamley Green Duck Pond – water level monitoring as 17 October 2023

Brief description

- The pond recovered to the full level in late July after dropping to about half the pond depth in late June following a 33-day consecutive dry period (from 16 May to 17 June).
- A second dry period from 1-17 September accompanied by very high temperatures saw the pond level reduce again to about mid-depth but recover quickly in mid-September due to two days of intense rainfall (21 and 29 mm/day).
- The groundwater level monitoring well installed in early June shows a similar pattern to the pond level. This is discussed in more detail below.





Overall, the rainfall from May-September 2023 was 88% of the mean (as measured at Wisley) although this masks considerable variations within months and between months, e.g., with considerably less rainfall in May and June and considerably more in July.

Table comparing 2023 monthly rainfall (SG) with seasonal averages (Wisley) (mm)

	Wisley (monthly mean 1991-2020)	**Shamley Green (2023)**
May	47	31 (66%)
June	47	20 (43%)
July	49	64 (131%)
August	57	48 (84%)
September	54	61 (113%)
Sub-total	**254**	**224 (88%)**

Commentary

These notes are preliminary - further insights can be expected next year when we have a full season's data of groundwater measurements from April to October.

- The drop in pond water levels is very dependent on temperature. During the 5 week period of no rainfall between 12 May and 17 June 2023, the pond dropped at an average of 2.9 mm/day over a two week period when the average noon-time temperatures was 18C. This loss rate is consistent with evaporation estimates from various websites for normal climate conditions in the UK, suggesting that there was no significant leakage from the pond.
- The rate of loss increased substantially to 8-10 mm/day when the average noon-time temperature reached 27C. This rate of loss is higher than what we could expect from open water evaporation alone (say 5-7mm/day for these high temperatures) but maybe explained by a significant increase in the evapotranspiration from the willow tree and other vegetation which draw water from the pond (maybe in the region of an additional 1-2 mm of pond depth per day when temperatures are high, daylight duration is longer, and it is the season of increased plant growth).
- In terms of pond recharge, the average historic rainfall of about 10 mm per week appears sufficient to provide a modest recharge to the pond of about 30mm depth. More intense rainfall obviously results in considerably more recharge, with the rainfall event of 50mm over three days (18-20 September 2023) leading to a rise in pond level of 140mm. The amount of water running off into the pond also depends upon the dryness of the soil profile in the catchment at the time.
- There is a very close correlation between the pattern of pond levels and groundwater levels shown on the graphs. To explain this, we look separately at the periods when the pond level is being depleted (water level dropping) and when it is recharging (water level rising):
    - **Dropping levels:** During dry periods, the surface water from the pond evaporates depending on air temperature and wind. At the same time the groundwater is probably flowing naturally to the nearest stream. Trees are also extracting water from both the pond and the groundwater. The trend is therefore downward for both pond level and groundwater level. If the puddled layer in the pond bed is completely impermeable and doing its job, then the pond will not be recharging (seeping into) the groundwater. If there is a leak, then its magnitude would depend upon what is called the 'hydraulic gradient' – the difference in elevation between the pond and groundwater levels. Over the season, the hydraulic gradient varied from 24cm to

46cm and there does not appear to be a correlation between the hydraulic gradient and the rate of decline of the pond level. Also, as the pond evapotranspiration rates appear to be reasonably close to expected values for days with high temperatures, (see discussion above), then the extent of any seepage appears limited.
    - **Rising levels**: The rainwater in the catchment area partially runs off to the drainage network to refill the pond and partially infiltrates down to the groundwater to recharge it. Both pond and groundwater levels will rise following rainfall events, with pond levels rising slightly earlier as the flow route through surface drains should be more direct. The upward trends on both graphs following rainfall is expected.
- It is not possible to rule out the possibility of limited seepage from the pond, and it could also be of an intermittent nature due to penetration by roots or animals and then sealing through siltation. Any seepage would be more likely through the pond bed rather than the sides of the pond. If there were to be a leak in the side of the pond, then one would expect the rate of loss to reduce once the water level drops below that elevation, whereas the rates of water loss in both 2022 and 2023 were relatively consistent regardless of pond water level.

Possible actions:

- The highest priority from a hydraulic point of view is to maximise the flow into the pond when it does rain by keeping ditches clear and fixing any leaking pipes from the land drains that lead to the pond. Other considerations also need to taken into account such as the ecological benefits of more naturally shaped ditches and any labour implications.
- The pond is very shallow - about 50 cm maximum depth from the spillway level to top of clay puddled layer. Due to siltation over the years, this depth has reduced to about 42cm. With climate change, the frequency of extended dry periods is likely to increase, meaning drying out of the pond will become a more regular occurrence than in the past. Apart from the ditch clearance program, other options to mitigate this include:
    - Marginally increasing the pond depth if possible by 5-10cm by raising the spillway height could delay any drying out by 5-20 days depending on temperatures.
    - Physically removing the silt from the pond bed would increase the depth temporarily. But there are some physical benefits of maintaining a silt layer in the bed of the pond as it protects the clay layer from cracking when the pond dries out and there are practical questions about where to dispose of the silt.
    - Constructing a silt trap upstream of the inflow to the pond has been suggested and is worth exploring further. It would partially reduce sediment entry to pond in normal flow conditions, but is unlikely to be effective in periods of heavy rainfall which are also expected to become more frequent in the future. Reviewing experiences from other ponds in the vicinity with this feature would be worthwhile.
- Re-puddling the base of the pond or introducing a lining to reduce permeability and minimize any seepage loss from the pond would both be very disruptive and expensive and the benefits are questionable at this stage.
- Whenever trees and plants need to be replaced in the vicinity of the pond, consideration could be given to the use of less water-demanding varieties.

Jerry Bird, 17 October 2023