Hydrology of the Wetland Spring in Trendlewood Park Nailsea

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Introduction

Trendlewood Community Park in Nailsea is divided into a series of 'Compartments', these divisions are used to support the management of the park. The map in Figure 1, below, shows the compartments of the park that are mentioned in this document.

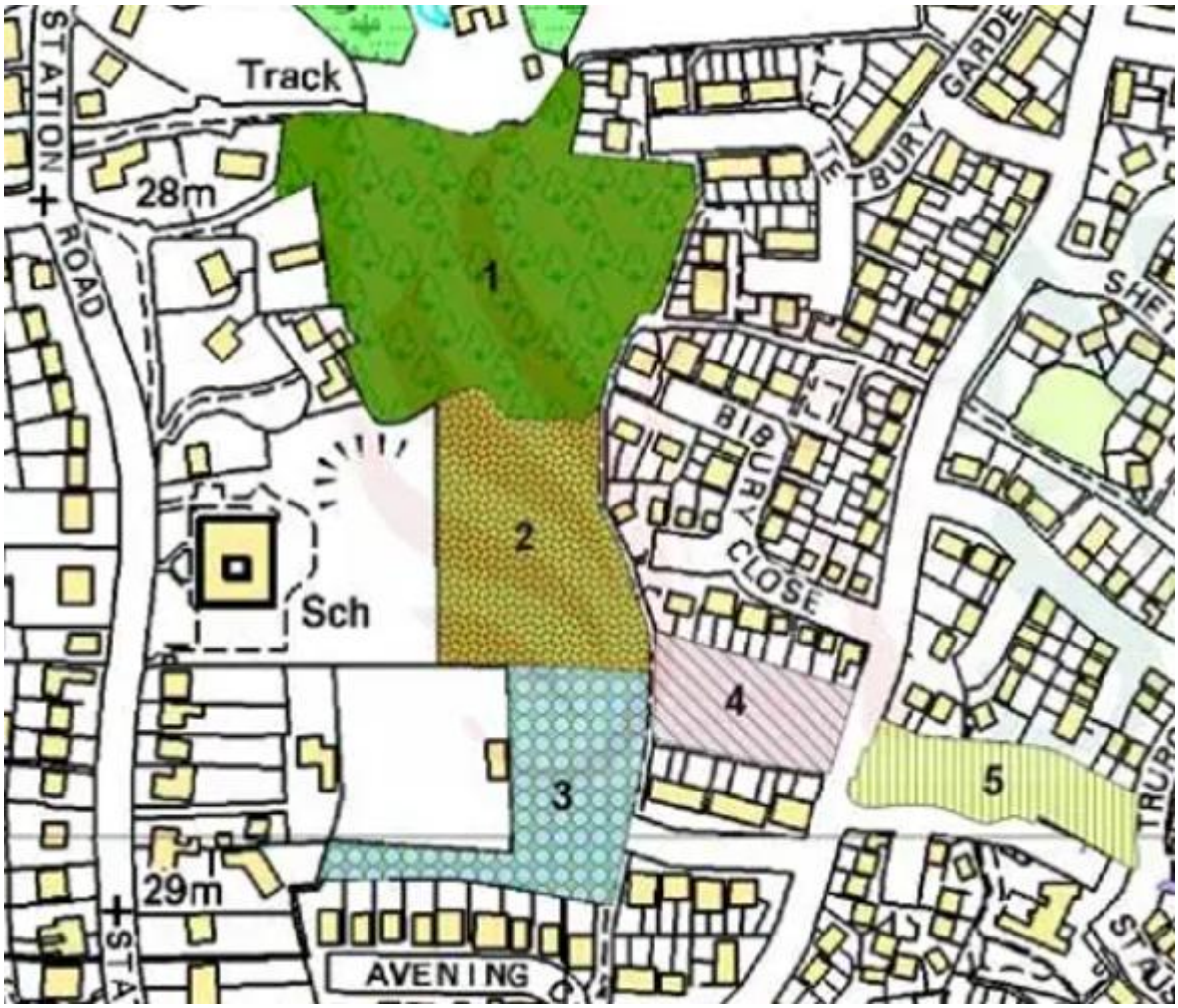


Figure 1 Trendlewood Community Park Compartments

Trendlewood Community Park in Nailsea does not have any standing water, but Compartment 1, Nowhere Wood, has a seasonal pond and Compartment 2 has a wetland area in which spring water comes to the surface for part of the year.

The 2016 Management Plan for Trendlewood Community Park, written by North Somerset Council, contained the following statement about the park's history:

'Compartments 4, 5 and 6 were originally the course of a stream that ran down off farmland and into the River Kenn. Developers largely infilled the valley cut by the stream, and culverted the water. The course of the stream is still visible today, and a line of mature trees grows along it.'

The stream referred to would have been fed from the spring in Compartment 2 as the spring and wetland areas are immediately next to Compartment 4 at the head of its valley.

The spring is curious in that it is a known historical feature associated with a cattle pond that has disappeared. For many years the spring did not flow and the area around the spring became dry. Modern mapping does not show the pond. However, in the 2010's the spring became a regular feature once more, flowing most years between October and May. The flow of spring water leads to the flooding of the wetland area close to the spring; it creates an ephemeral pond on the site of the old cattle pond. Why the behaviour of the spring changed is not certain. The following notes examine the location of the spring and the hydrology that supplies it.

The Geology of Trendlewood Park

Compartment 1 is mostly a disused Pennant Sandstone quarry. Pennant Sandstone is part of the Downend Formation (Dn), a sandstone with mudstone formation and some coal especially at lower levels. In our case the sandstone is the Pennant Sandstone that was previously extracted from the quarry.

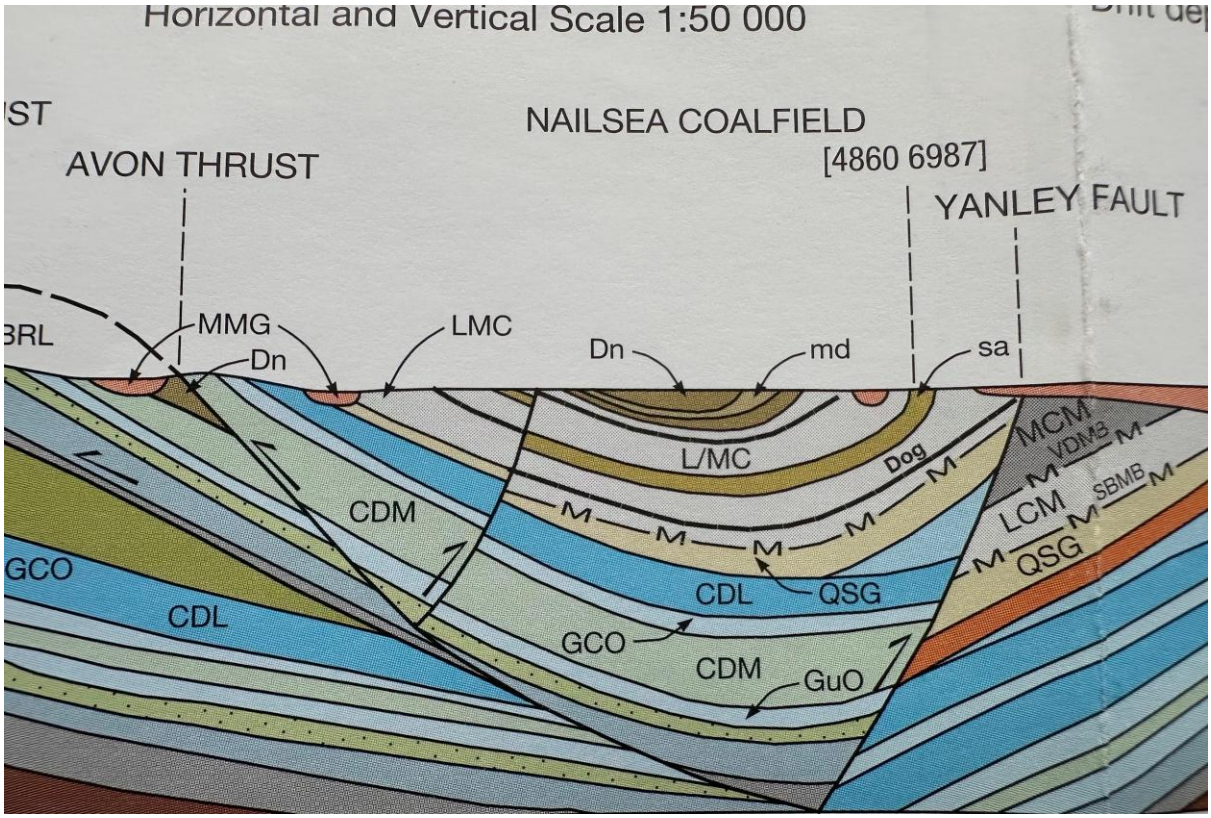


Figure 2 Nailsea Coalfield Vertical Cross Section

Figure 2, above, is a vertical cross section of the rock strata running north west to south east under the Trendlewood area of Nailsea and the surrounding districts. The Trendlewood area sits on the Downend Formation (Dn) and mudstone (md) in the centre of the image. The rock strata under Nailsea bends downwards in what is known as a syncline.

The surface geology is shown in Figure 3 below. The straight black line which bends at Backwell Common is part of the section used in Figure 2.

The thickest black lines in Figure 3 are where coal seams reach the surface and the thick black dashed line is a concealed coal seam. There are very thin coal seams within the sandstones, one of one can be seen in the quarry face in Compartment 1, but these are not shown in Figure 3 due to their thinness.

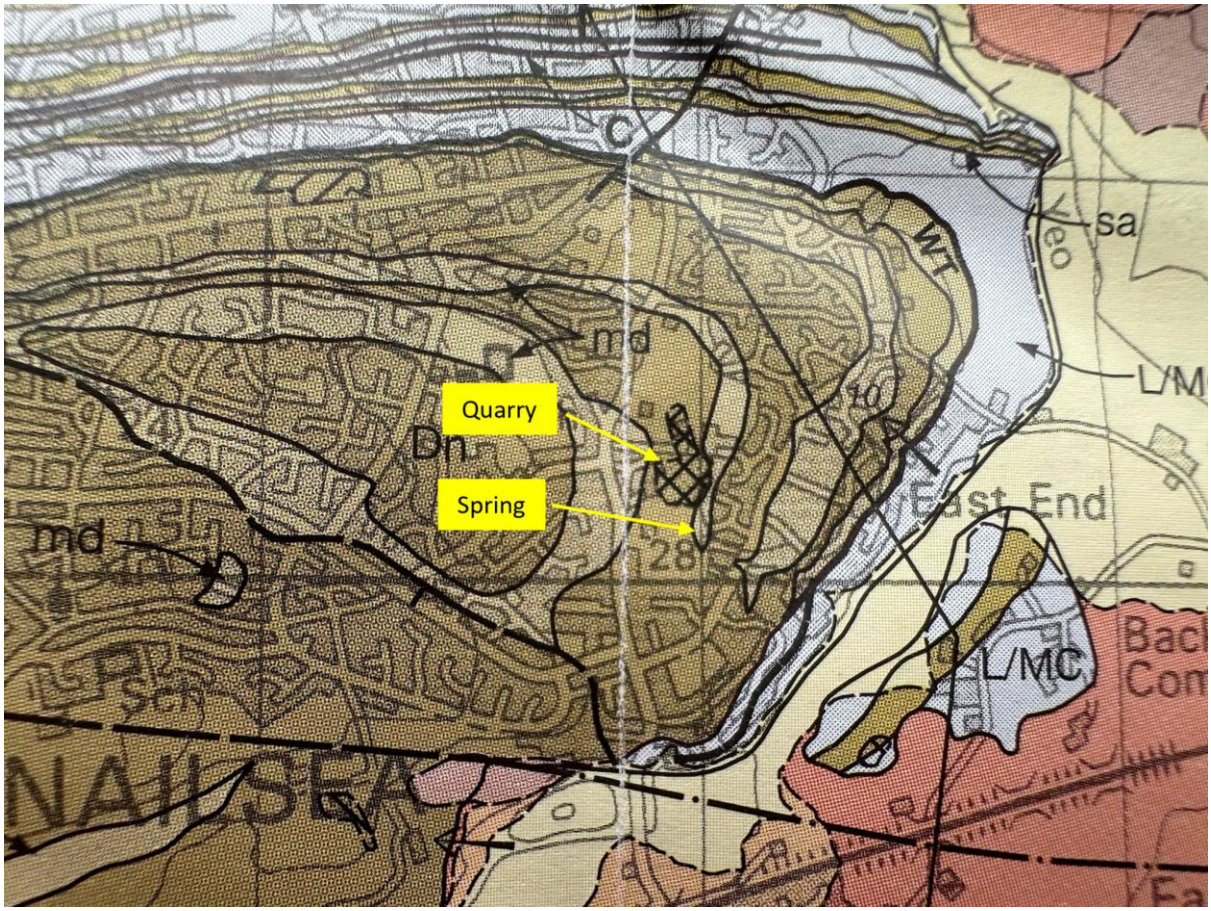


Figure 3 Surface Geology

The hatched area in Figure 3 is the quarry workings. The spring lies to the south of the quarry workings with the wetland area being joined to and southwards of the spring. The spring appears to lie on, or very close to, the surface boundary between the Downend Formation sandstone and mudstone. The mudstone is shown as the paler shade of brown in Figure 3.

Pennant Sandstone is a porous rock. The porosity of Pennant Sandstone is around 9% which is not particularly high, being less than the porosity of the Limestone rocks in the hills either side of Nailsea. Critically, Pennant Sandstone is more porous than mudstone. This will result in water being held within the sandstone above the mudstone. Where the boundary between the rock layers comes to the surface springs may occur. Figure 4 is an idealised sketch illustrating this process.

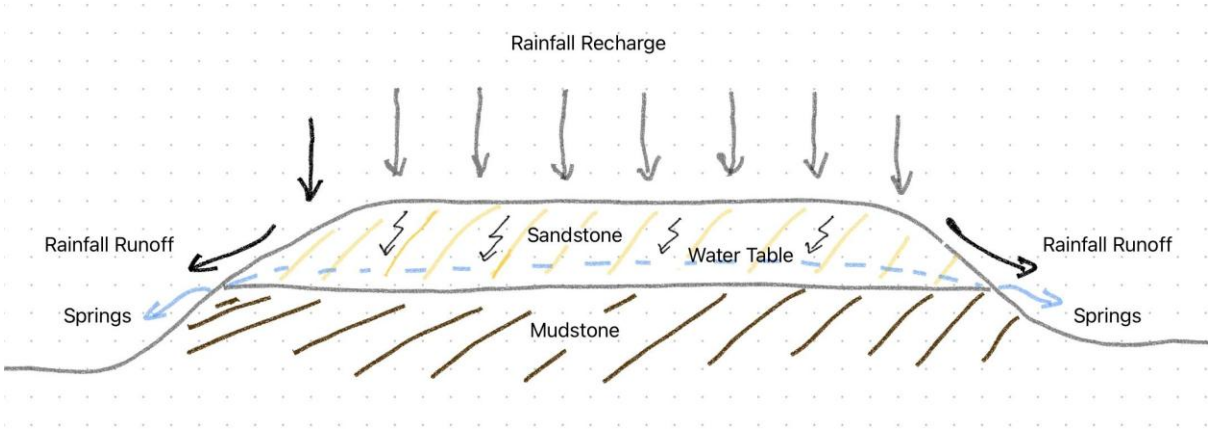


Figure 4 Idealised Sketch of the Water Table Under Trendlewood Park

The bedding of the Nailsea syncline in the quarry dips downwards in a north-westerly direction (in Figure 3 the arrow above the word 'East' is the generalised dip of inclined strata in degrees - in this case it is 10 degrees). The rocks in this area are part of the 660m deep Downend Formation. The upper beds are highly fractured, yielding the 'Nailsea Flats'. A combination of a porous rock and fracturing allows rainwater to seep into the ground and replenish the water table. The water is stored within the pores of the sandstone, like a sponge and will migrate downwards until it reaches a barrier to the downward flow. The water will then pool within the sandstone until it finds a way to escape. The top of the pooling is the height of the underground aquifer.

Nailsea is a relatively flat town situated on a geologically small area. Nailsea is higher in elevation than the countryside that surrounds it. Consequently, the water table within Nailsea has both a limited catchment area and a restricted reservoir capacity. The water table is likely to fluctuate as a function of rainfall more quickly than many other areas due to the small catchment area and limited volume of the reservoir. This is supported by stories that wells within Nailsea were often unreliable with a tendency to dry out after periods without rain.

The mudstone outcrop at the spring terminates nearby. The mudstone has either been eroded away to the south of the spring, or never existed, leaving sandstone at the surface. It may be that two strata of sandstone meet here with perhaps a thin layer of less permeable material at the interface between the strata, but there is no evidence to support this concept.

Excavation of the wetland area at the site of the old cattle pond revealed a layer of blue/grey clay about 70cm below the surface. This area of Nailsea is not part of the wider alluvial clay deposits found at lower elevations around the edge of Nailsea. At the time of writing there was no information on the extent or depth of this clay layer. Consequently, it was not clear if this clay layer was a natural deposit or perhaps introduced manually to line the cattle pond.

Topography of Trendlewood Park

LiDAR imaging allows us to look at the relative surface elevations in the park and the surrounding district.

In Figure 5 green areas are at a higher elevation than the grey areas. Examination of Figure 5 shows that the quarry floor is at a higher elevation than the spring. This implies that the quarry floor is above the typical water table height. This is probably the reason that the floor of the quarry is usually dry. The seasonal pond is at a similar elevation as the spring (the grey colouring in the LiDAR images) and may, therefore, partly respond to the water table level as well as to rainfall runoff.

We know the Gully in Compartment 2 is slightly lower than the spring, as the water flows from the pond into the Gully. However, when the flow of the spring water slows the Gully quickly dries out. Clearly the Gully depends on the spring for its water and not the water table level directly. Also, Compartment 4 is lower than Compartment 2 and slopes downhill to Trendlewood Way but it does not have a spring or hold any water, except in periods of very high rainfall.

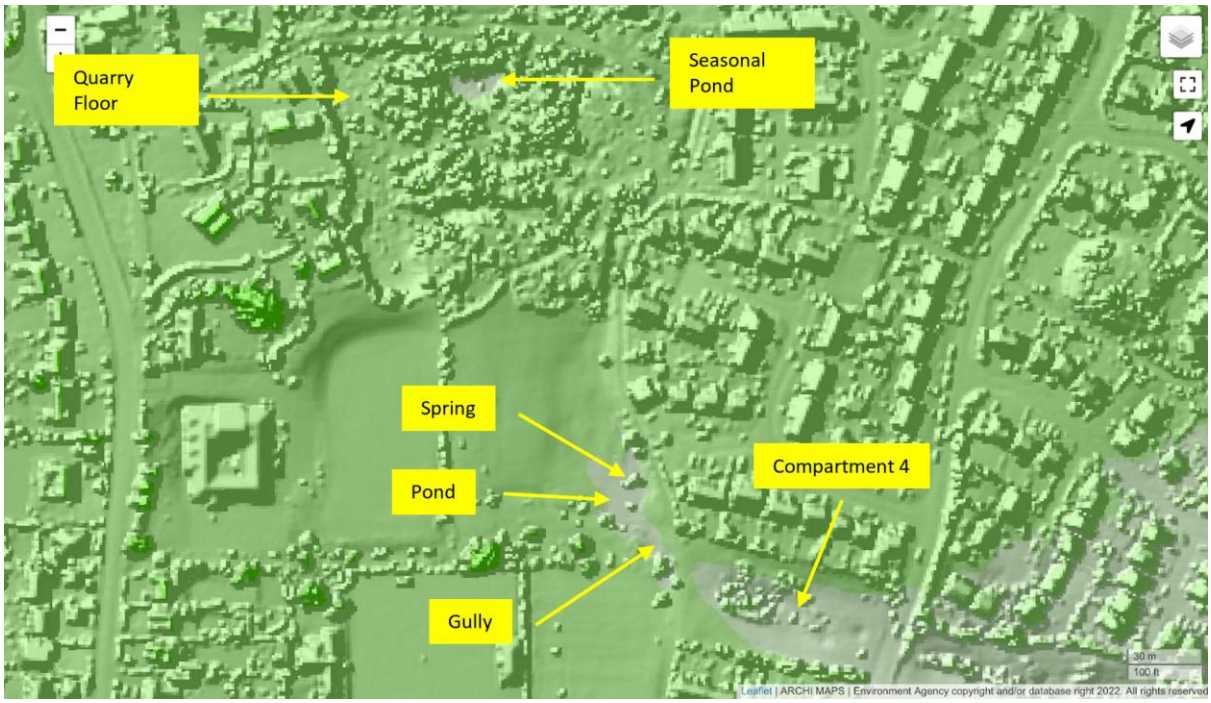


Figure 5 Compartments 1, 2, 3 & 4 Elevations

A possible reason for the Gully drying out and Compartment 4 being dry is that they lie over sandstone, not the mudstone. Looking at Figure 3 it can be seen that the mudstone outcrop finishes near the spring, being replaced by sandstone which continues down to Trendlewood Way. A further outcrop of mudstone then occurs in Compartment 5.

During work to enhance the biodiversity of Gully it was reported that a rock was lifted from the base of the Gully and remaining water in the Gully at the time then quickly drained away. It is

likely that lifting the rock unblocked access to the culvert that diverts the stream away from its original course. Alternatively, it may have disturbed sediments that were overlying the sandstone rock beneath the Gully.

The sandstone under the Gully is at a lower elevation than the spring and Compartment 4 is lower than the Gully, but neither area appear to be affected by the water table that feeds the spring nearby. It is surmised that the underground aquifer flows along the top of the mudstone strata after which it sinks into the sandstone to a lower depth until it encounters a less permeable layer.

The catchment area for the spring water is likely to involve some of the green coloured areas in Figure 6 and possibly beyond. In the Figure 6 LiDAR image, below, all of the ground to the west and north of the spring is at the higher green elevation. However, it can be seen from Figures 2 and 3 that bands of less permeable mudstone lay between the sandstone layers. This may result in different water tables being present in each of the sandstone layers.



Figure 6 Wider View of the Surrounding Catchment Area

The view in Figure 7, below, shows the ground in Compartment 2 sloping downwards in a southerly direction to the wetland area and the spring. The grass is mostly over sandstone resulting in rainfall both seeping down to the water table and on occasions running off along the surface to collect in the pond.



Figure 7 A View Across Compartment 2 to the Wetland Area

Hydrology

Water catchment in Nailsea is from rainfall. Historically there were streams in Nailsea but these have been buried in culverts and are no longer visible or able to interact with the surrounding geology.

When Nailsea was developed much of the surface area became impervious to water with drains being installed to quickly move the water away. Backwell Lake is an artificial Balancing Pond built to absorb sudden water out flows from Nailsea and release them at a slower rate into the River Kenn. These changes cut off some of the flow of water into the underground aquifers. This is likely to have affected the water table heights under Nailsea due to a reduction in the volume of water held by the underground aquifers which in turn starved springs and streams of their water supply. This may have been compensated to some extent by the decline in water extraction due to the spread of mains water usage and the demise of water intensive industries such as cider production.

The following schematics from ‘Practical Engineering’ illustrate how a town development reduces rainwater access to the underground aquifers. A similar process has occurred in Nailsea.



The area to be developed. It is fields and woodlands. Rainwater can soak into the ground and feed the aquifers below ground.



Tarmac or concrete access routes are built together with surface water drainage system to quickly remove water from the area to prevent flooding.



Infrastructure is added. These are all impervious structures reducing the collecting area available for rainwater to soak into the ground.



Development continues, further reducing the land area that can absorb rainfall.



Finally the town is complete. Large areas of ground are covered over with impervious materials and the drainage system quickly removes much of the rainfall from the area. This greatly reduces the supply of water to the underground aquifers.

Some wells still exist in Nailsea but data for any wells close to the park was not available. The car wash at the Touts service station in Wraxall takes its water from a well 50m deep and apparently has never run dry. While a well at Heath Cottage is 20m deep and reported to usually have a water level that is about 10m down the well shaft.

The seasonal pond in Compartment 1 is ephemeral, being dry for many months each year. The pond in the garden of the nearby 'The Old Quarry' does not dry out, but is probably in a deeper excavation that intersects with the water table.

East End Farm, now the Old Farmhouse public house, had four wells in its grounds. As the farm is at a lower elevation than the central part of the park it is likely that the water table in that area was more accessible.

Modern water extraction for drinking is taken from Clevedon and is not thought to be extracted from under Nailsea. Consequently, the reason for the spring drying up is unlikely to have been directly related to water extraction, more likely is the reduced catchment area. However, that does not explain why the spring has re-emerged.

<u>Rainfall Data</u>

The Table 1 below is based on rainfall measured at the Meteorological Office station in Yeovilton and regional averages. Yeovilton is close enough to Nailsea to identify trends but not precise rainfall amounts due to locational differences and spatial separation of the two locations. To understand regional trends, data for South West England and South Wales and also for Southern England are included in the table below.

Periods (rolling 29 year periods)	Yeovilton Average Annual Rainfall mm	England SW & Wales S Average Annual Rainfall mm	England S Average Annual Rainfall mm
1961 to 1990	718.2	1,198.13	761.17
1971 to 2000	742.52	1,237.11	776.07
1981 to 2010	708.54	1,255.26	791.42
1991 to 2020	729.73	1,277.37	807.99

Table 1 Rolling 29 Year Rainfall Averages

Nailsea being closer to the Severn Estuary and South Wales is unlikely to reflect the totals recorded at Yeovilton and Southern England. The England South West and Wales South data includes areas that are further westwards and often higher in elevation than Nailsea, these factors are likely to lead to higher precipitation rates to those experienced in Nailsea.

Overall, the rolling 29-year trend data in Figure 8 shows increasing rainfall since 1961, although Yeovilton has a slight decrease in the period 1981 to 2010. To establish if Nailsea had a similar trend, data recorded at Wrington between 1990 and 2017 was examined, this is shown in Figure 9.

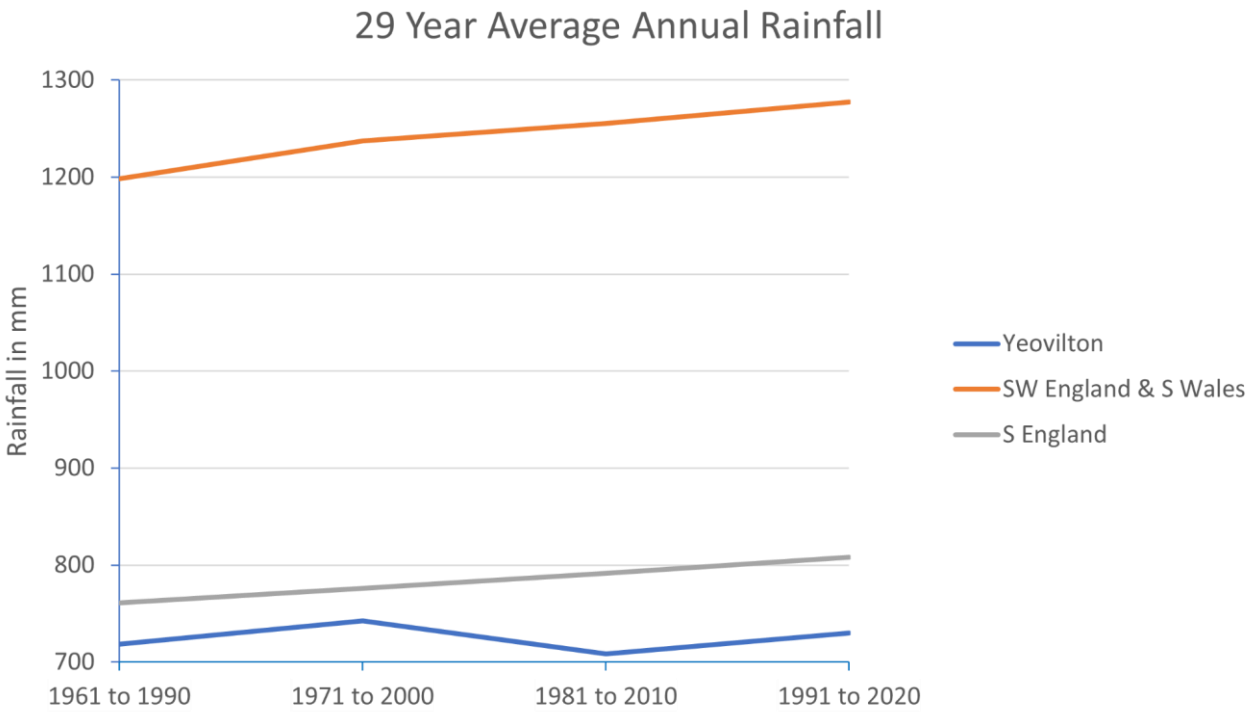


Figure 8 29 Year Rainfall Averages Trend Lines

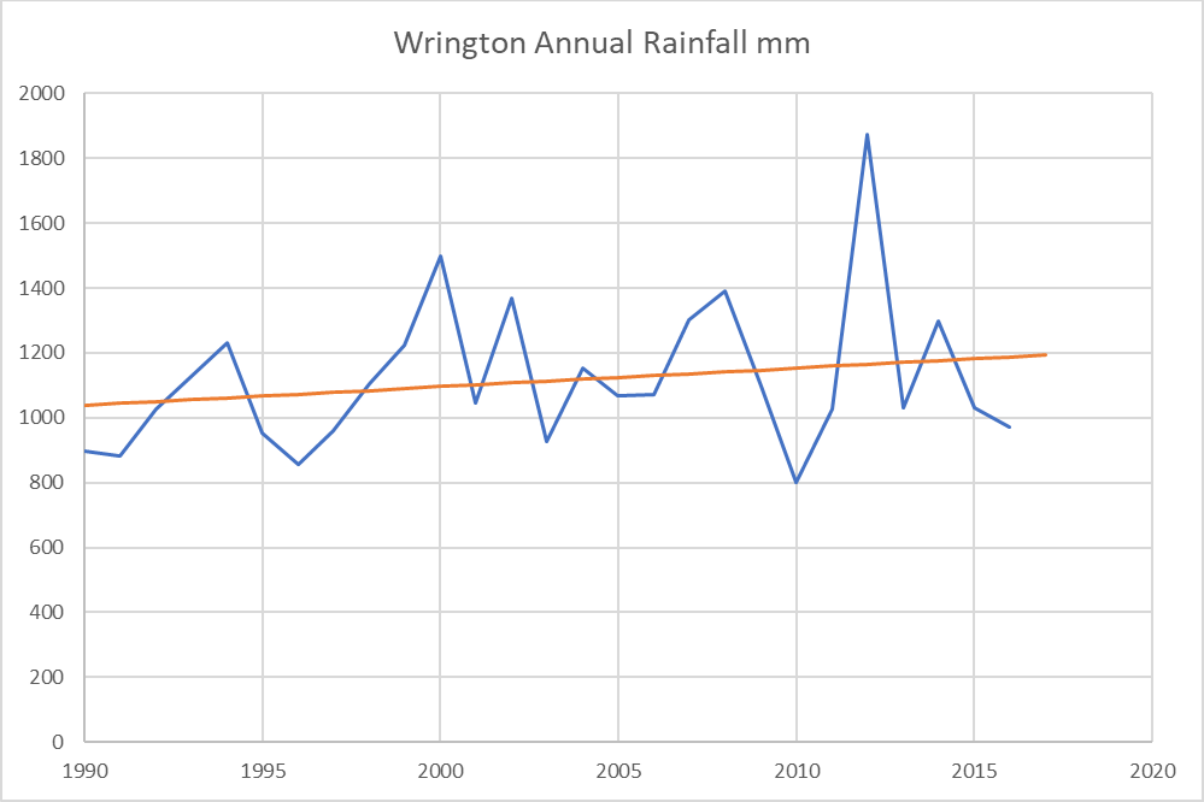


Figure 9 Wrington Annual Rainfall

The Wrington data shows higher precipitation rates than Yeovilton or the Southern England average, being closer to South West England and South Wales data. The trend lines for all the data shows a general increase in annual rainfall totals.

While yearly fluctuations (the blue line in Figure 9) occur overall the amount of rain falling is increasing over time. When Nailsea was developed in the 1980's some of the catchment area was paved over and drainage installed. This would have reduced the flow of water into the underground aquifers which would have lowered the water tables. The trend at Yeovilton has a slight dip around the period that Nailsea was being developed, it is not known if a similar trend was seen at Nailsea, but if it was it would have exacerbated the lowering of the water table. Subsequent increase in precipitation may have been enough, over time, to raise the water table to the point where spring once again flowed.

Flood Risk and Drainage

Figure 10, below, is the surface flood water prediction covering Trendlewood Park Compartments 1, 2, 3, 4 and 5. This data reflects the surface topography and shows where surface water would go once the ground is saturated and no longer able to absorb the water. As such it does not inform us about the water table or the spring. However, under such conditions the spring flow rate is likely to be high causing the Gully to flow over the footpath into Compartment 4.

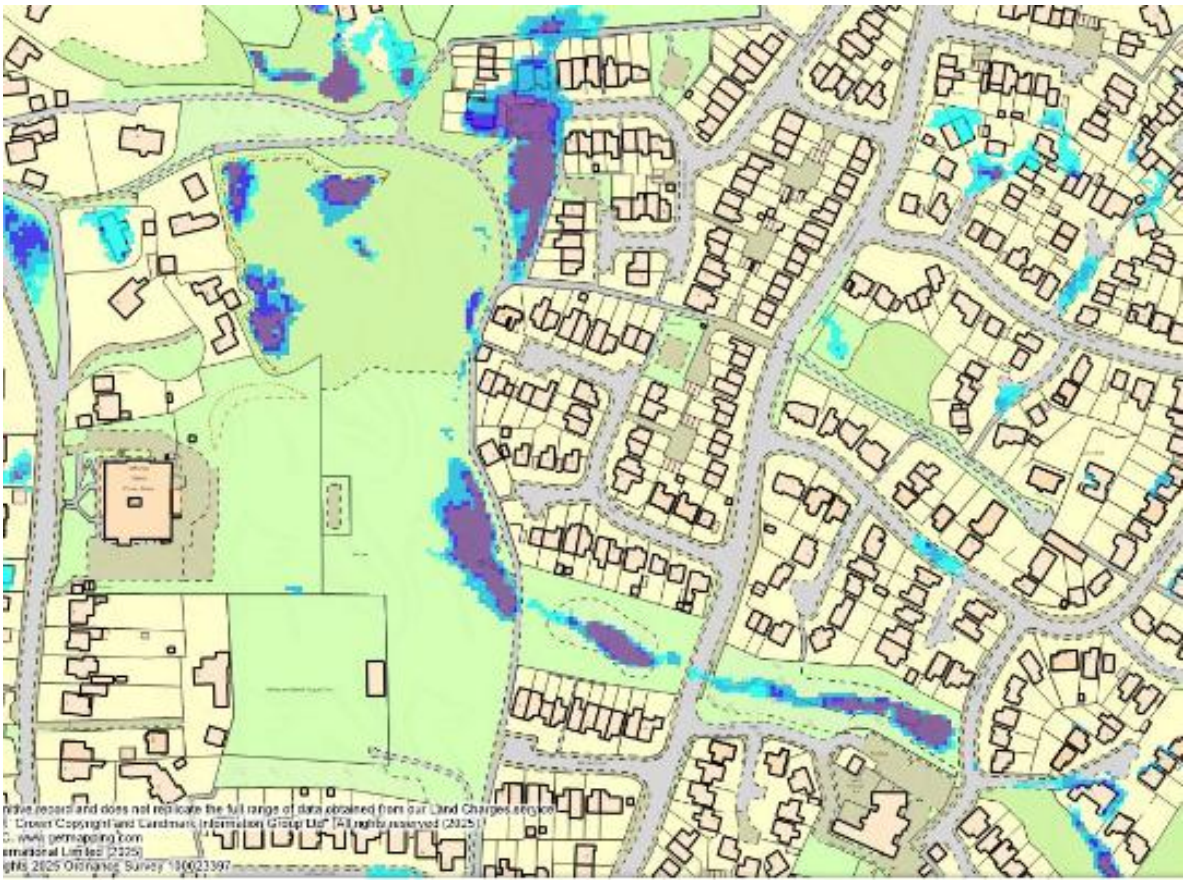


Figure 10 Surface Flood Water 2025 Prediction

Figure 11, below, shows the surface water drains near the wetland area and spring in Compartment 2 and their route into Compartment 4. Surface water sewer 375 passes alongside the spring and pond locations before it is joined by another drain running next to the location of the Gully. There is a manhole cover at the point of their intersection, shown by a small circle in the figure below. The experience during the enhancement the biodiversity of the Gully suggests that a drain access to this surface water sewer was unblocked. If correct sewer

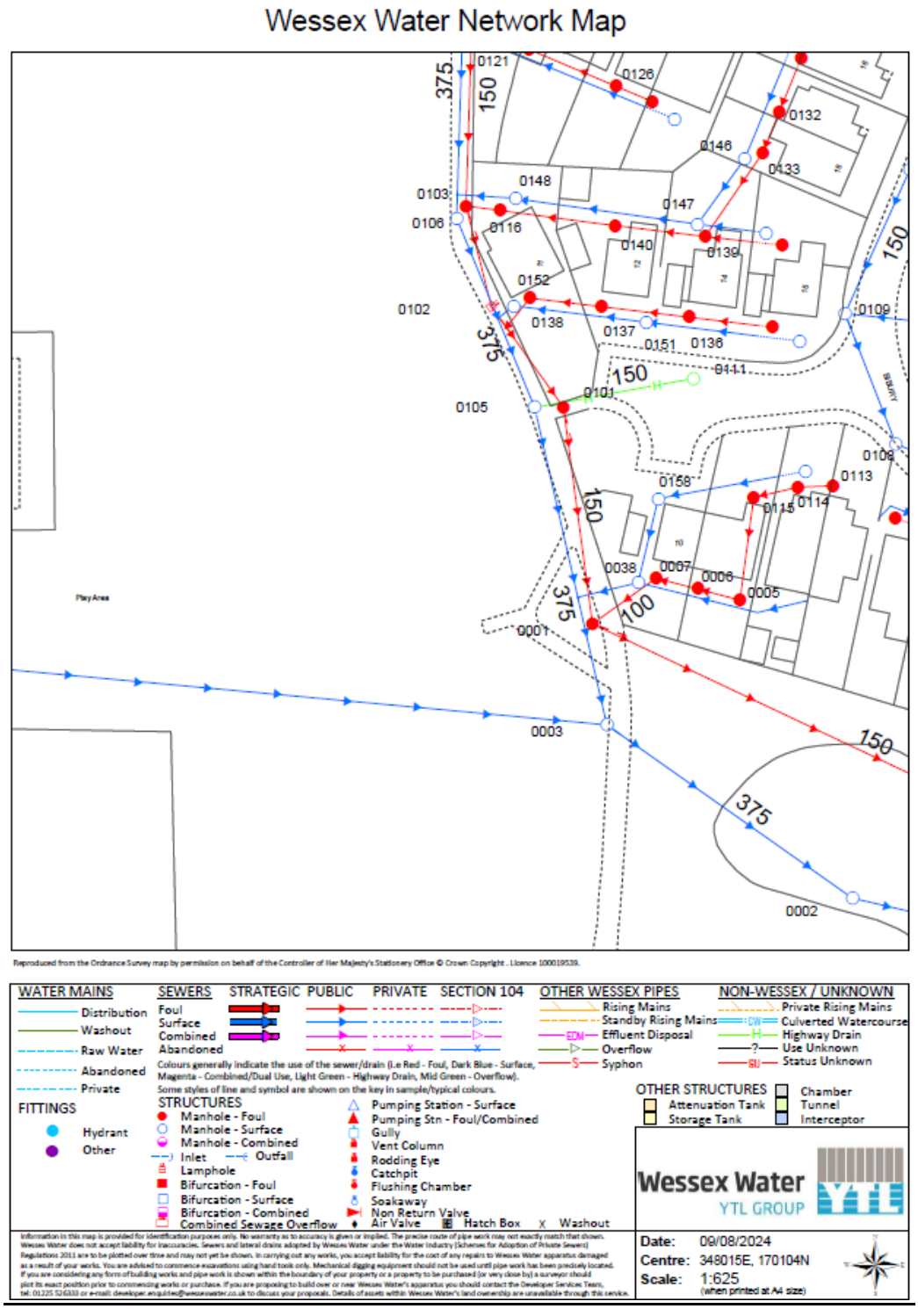


Figure 11 Surface Water Drainage Map

375 is the culvert referred to in the park management plan and, if not blocked by debris, excess water from the spring is channelled away through sewer 375, thus keeping compartments 4 and 5 free from flood water.

Conclusions

The spring exists at the point where less permeable mudstone outcrops at the surface. The overlying sandstone is more porous and acts like a sponge holding water that has permeated through the ground from rainfall.

It is likely that the spring and its associated pond dried up because the development of Nailsea reduced the catchment capability that fed the underground aquifer. Some surface water previously able to soak into the ground was instead quickly removed by drainage which prevented it from entering the underground aquifer.

Less water has been extracted from the underground aquifers over time due to the introduction of mains water supply replacing wells and the demise of water intensive industries. The reduction in water extraction together with the long-term increase in rainfall is likely to have caused the water table level to rise, leading to the spring flowing once again.

The geology under Nailsea limits the volume of the water table reservoir which means that it is particularly sensitive to periods of low rainfall and also sensitive to the loss of catchment area.

The Gully and Compartment 4 are situated over sandstone, consequently, the ground is porous and water there quickly soaks away. However, there is a clay layer beneath site of the old cattle pond, but the extent of the clay layer is not understood. If the clay layer extends beyond the cattle pond site that would prevent water loss into the sandstone in the areas where the clay is present. The Gully may also be at the entrance of the culvert, this is most likely to be Sewer 375. If correct Sewer 375 takes excess spring water that gathers in the Gully and drains it into the surface water drainage system.

The pond is fed by the spring and may partially lie over sandstone, if so its ability to hold water would be poor. However, there is a layer of clay under at least part of the pond site which has low permeability. The pond was once a cattle pond and the clay may have been introduced historically to line the pond.

The Seasonal Pond in Nowhere Wood is likely to interact with the water table that feeds the spring. It is at a similar elevation as the spring and is within the same rock sequence. Visual observations have noted that the depth of water in the Season Pond appears to correlate well with the flow rate of the spring, although these parameters have not been precisely measured.

References

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Images

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Simon Stannard.

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YouTube - Practical Engineering

North Somerset Council definitive Map.

Wessex Water Network Map.