An investigation into untreated effluent being discharged in to Pagham Harbour

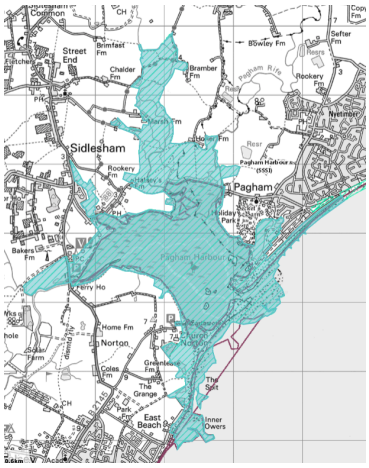
Objective: The following is an investigation into reported incidences of sewage being discharged into the Pagham Harbour. It also examines whether objections from residents and local Parish Councils against planning applications for large housing developments are valid (or unfounded) on the grounds that Pagham Wastewater Treatment Works is unable to handle the present and future volume of wastewater.

Findings: Pagham wastewater treatment works has capacity to accommodate maybe only 1,100 new homes, and certainly not the 1,200 in the Local Plan without expanding this treatment facility. But the catchment area in fact reaches out also to North Mundham and Hunston and any developments taking place in these locations are also relevant to Pagham WTW. 'Spills' into the Rife of unprocessed wastewater at times of heavy rainfall and where rate of flow exceeds the WTW control parameters is of significant concern. Adding new homes of this magnitude will most certainly compound that problem. The community is therefore right to be concerned to an extent as regards the 2nd objective, but most definitely on the 1st objective.

The following report examines the efficacy (effectiveness) of the wastewater treatment process, what 'spills' in recent times have occurred, and the consequences of these. At the end are conclusions and summary and I leave to the reader to decide how much of the middle bit you read.

This is the 2nd investigation report this author has published on the subject. The 1st version had to be retracted / recalled as it was based on incorrect and incomplete information provided by Southern Water Services and which, accordingly, was therefore compromised and led unfortunately to totally incorrect conclusions. Now hopefully we have all the facts and this will give us greater insight into the process and how and why maybe we too in the community are not necessarily helping matters.

Pagham Harbour



Paghan Harbour is a 625 hectare (1,550 acre) biological and geological Site of Special Scientific Interest on the western outskirts of Bognor Regis, West Sussex. It is designated a geological conservation review site by the UK Joint National Conservation Committee, is a Ramsar wetland UNESCO protected site, a special protection area (SPA) under EU Directive, a recognised marine conservation zone under the Marine & Coastal Access Act (2009), and, supposedly, a local protected nature reserve under the supervision and management of the RSPB.

If you google it you will find all sorts of information and historic scientific research carried out on the harbour over many years and learn all about intertidal sediment dynamics from the University of Brighton under its 2000-2025 project study, Natural England's conservation objectives outline for this harbour published 2014 and of NE's Site Improvement Plan published 30th October 2014, a report from the Inshore Fisheries Conservation Authority where you can read all about protecting seagrass beds, Defolin's lagoon snail, sand shrimps, as a sheltered fish nursery, for water voles, its importance to migratory and non-migratory bird species in danger of extinction or now vulnerable including Little Terns, the Common Tern, the Wintering Ruff and the Dark Bellied Brent Geese, RSPB publications including its 2013-2018 Pagham Harbour Management Plan, the Department of the Environment, Food & Rural Affairs Ministry publications describing the importance of Pagham Harbour, the Wildlife Trust, etc etc. The list is long. The entire harbour is protected. You are not permitted to swim in it, fish in it, dig for fishing bait from it, operate any towing geared activity such as trawling or skiing or canoe in it. Only simply walk around it and admire the wildlife within.

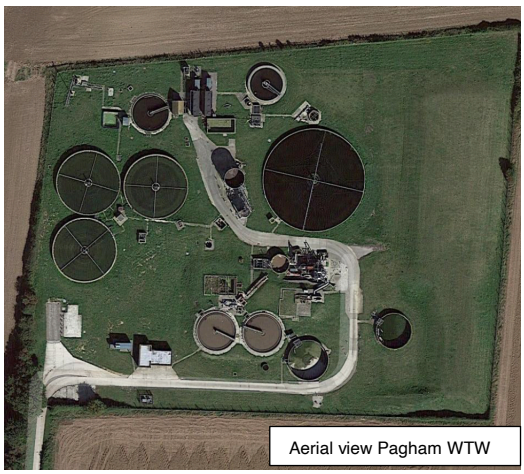
Notwithstanding what you have just read and learned what these agencies have to say about the importance of protecting Pagham Harbour, there are in fact 2 wastewater treatment works releasing processed effluent into this harbour in ever increasing volume. But, and more importantly, Pagham Harbour is not in fact considered by the Environment Agency to be a 'sensitive' area and therefore does not require the same effluent treatment process as is required for Chichester Harbour which has such designation.

Sidlesham Wastewater Treatment Works via The Broad Rife and the Pagham Wastewater Treatment Works via the Pagham Rife are licenced by the Environment Agency to release treated wastewater effluent into this harbour. The Bremere Rife and maybe Forebridge Rife, Keynor Rife and Red Barn Ditch, also carry ground water from farm land into the harbour occasionally, although in the event of serious flooding these could potentially cross contaminate (infiltrate) with the combined sewage system.

Pagham Wastewater Treatment Works

Wastewater treatment works are subject to a Dry Weather Flow ['DWF'] permit issued by the Environment Agency ['EA']. For Pagham WTW Southern Water advised on 8th Oct 2020 that this is 2,309m^3 (cubic metres) daily. DWF is essentially the maximum permitted release of processed effluent with reference to the drier months of the year (1st May through 30th September) and is based on a very complicated formula of DWF = PG +1_{DWF} +E * and adjusted by an 80% tolerance of total daily flow values in a 12-month period. This represents a control parameter so that in those drier months the volume of treated effluent released is adequately diluted during the lowest period of water mass into which it is being released. But for periods when there is heavy rainfall EA has given a 'consented' 3xDWF (6,927m3) permitted release permit, although this is limited to a maximum flow rate of 59 Litres per second (5,097.6m3 per day) setting on the Combined Sewer Overflow. [1 cubic metre = 1,000 Litres]

*[P = catchment population: G = per capita domestic: 1dwf = dry weather infiltration: E= trade effluent flow].



Aerial view Pagham WTW

Southern Water Services ['SW'] advised that it is currently processing approximately 1,770 m^3 per day at Pagham WTW and therefore in relation to the housing developments in the Pagham district, they advise that the headroom of 539m^3 [2,309m^3 minus 1770m^3] equates to being able to accommodate an additional 1,600 potential new dwellings. If needed SW advise that they could seek from EA a higher permit, subject to satisfying a very stringent 'no deterioration principle', meaning the output sampling result must be same or better so that '…the total load to the environment is not increased'.

Pagham WTW has a storm tank of capacity of 597 m^3 to provide for volatility in wastewater volume. A Combined Sewer Overflow mechanism is set at 59 litres per second to avoid backflow to homes and gardens and the possibility of pipe network or pumping station failure.

Excessive flow rate of wastewater exceeding the 59 l/sec flow rate CSO setting is diverted into this storm tank and would return to the process once this flow rate falls back to <59 l/sec. Only if the tank is full and the CSO control parameter continues to be exceed will a 'spill' of unprocessed or only partially processed wastewater be released into the environment (the Rife).

SW have emphasised that the only issue it has currently concern old pipe network and pumping stations which will need upgrading and will take 24 months to complete. Meantime, P/134/16/OUT (Land North of Sefter Road, 280 dwellings), P/58/15/OUT (Summer Lane, 90 dwellings) and P/18/20/PL (4 dwellings) have been told they cannot connect to the public sewage system until these works are complete. The same decision is expected for the other developments in the district. Interesting, however, is that this was not the outcome of a development in North Mundham under Chichester District Council which was approved August 2020 to connect to the Pagham WTW.

Other developments outline approved are P/140/16/OUT Church Barton Farm, Land South of Summer Lane & West Pagham Road, 400 dwellings +70 bed care home +2,000sqm new local centre +1FE school; P/25/17/OUT Church Barton House, Horns land, 65 dwellings: P/30/19/OUT Land North of Hook Lane, 300 dwellings +80 bed care home +2FE school: P/125/14/PL Land rear of 251 Pagham Rd 40 dwellings (completed): P/58/19/PL Rear of Inglenook Hotel, 9 dwellings. (consent refused, but now subject to appeal to Sec of State).

Developers wishing to proceed in advance of the pipe network enhancements are expected to build own adoptable pumping stations and underground storage vessels and to transporting untreated wastewater by HGV tankers to other WTWs for processing until permitted to join the main public wastewater system. These developments are it seems planning to take this course of action and Sidlesham WTW is a designated receiving centre for wastewater tankers, but more likely it will be taken on a round trip to Ford WTW some 12.5 miles distant. OFWAT apparently introduced a new charging mechanism on developers in April 2018 changing it from total cost of infrastructure enhancement to be paid by such developer to a fixed charge per dwelling for new wastewater connections, and SW only has 24 months from planning consent being granted to complete its works or it becomes responsible for any mitigation such as tankers to take away wastewater from site.

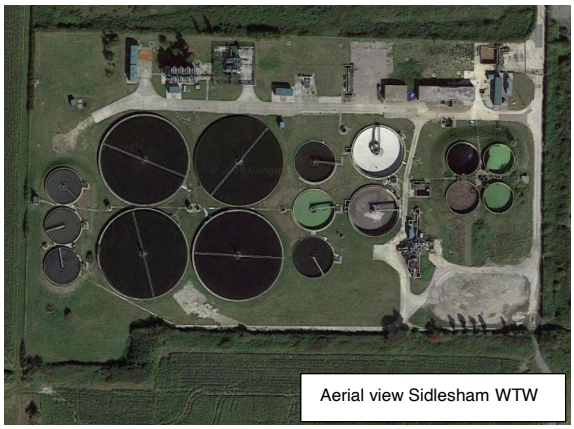
Pagham WTW catchment area in fact covers North Mundham, Hunston, Runcton, Lagness, Nyetimber, Pagham and maybe some parts of West Aldwick and South Bersted. Therefore, any concerns in relation to Pagham WTW has far wider implications.

Older properties in the area, pre-1960's, typically use combined wastewater and rainwater drainage systems where all water goes to the wastewater treatment works irrespective. Newer builds or extensions to old properties are subject to now building regulations requiring rainwater to be segregated and piped to soakaways or storm water systems and waterways and no longer permitted to be mixed with domestic wastewater. Many developments now also add landscaping with ponds or ditches to help handle heavy periods of rain and these are often referred to as SuDs [Sustainable Drainage Systems]. While SuDs installations certainly substantively help this process, it is apparently by no means absolute if rainfall is greater than it is designed for or the SuDs is not adequately maintained and where it can, consequently, still lead to cross contamination/infiltration.

Based on SW's calculation of 1,600 new dwellings that can be supported by a headroom of 539m3 works out to be on average 336.8 litres per day. If you have a water meter you can actually work out for yourself what you use as the bills tell us how many cubic meters consumed and this is also the basis for sewage charges and, unless you are always washing your car or watering your garden, then what goes out is the same as what comes in. However, SW has subsequently advised that it is in fact more appropriate to use 500 litres per day per average household because the effectiveness of SuDs deteriorates over time leading to infiltration / cross contamination. Based on this different number the headroom of 539m3 could then only support 1,078 new dwellings in total and covering all locations within its catchment area.

Sidlesham Wastewater Treatment Works

Sidlesham Wastewater Treatment Works holds a dry weather flow ['DWF'] permit of 5,800m3 as confirmed by SW on 8th Oct 2020 and says it is currently processing on average 5,321 m^3 per day. At times of high rain fall it has a 'consented' limit of 4xDWF (23,200m3), but similarly is limited to a maximum Combined Sewer Overflow control flow rate of 201 Litres per second (17,366.4 m3 per day). It has a storm tank with capacity of 1,266m3. Similarly, during periods of high rainfall, this flow is redirected to the storm tank when flow exceeds 201 l/sec and then returned back into the process once the flow has resettled back to below the CSO parameter. But once the storm tank is full and flow rate continues to exceed this limit then wholly unprocessed or partially processed wastewater is released into Broad Rife.


Aerial view Sidlesham WTW

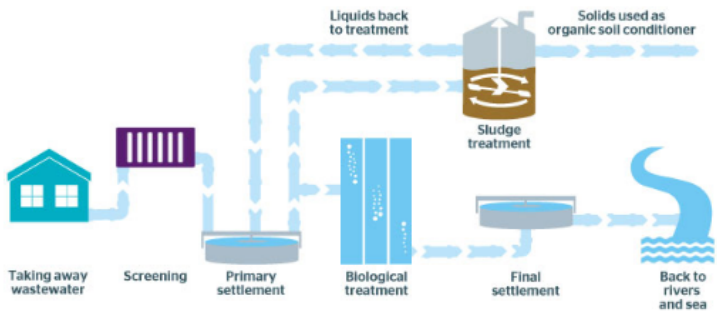
Sidlesham WTW's coverage area is 46 pumping stations over a 36km pipe network covering Almodington, Birdham, Bracklesham, Selsey, Sidlesham, East & West Wittering, West Itchenor and all properties in between.

In 2015 it was reported to be covering 10,500 domestic dwellings, but that number will have substantively increased over the last 4+ years with new builds, and particularly in Selsey. There are also localised Combined Sewer Overflow mechanisms situated at East Beach Road, Crablands and at Church Road which would release excessive wastewater overflow at those points directly to the sea, and an Environment Agency beach sampling report for Selsey suggests via an outlet some 14k out to sea.

According to the 2015 'Southern Water Drainage Strategy (Manhood Peninsular)' publication, Sidlesham WTW was recognized by SW and also by the EA as high-risk flood Zone 3 category with a >1% annual flooding probability and therefore very susceptible in conditions of high rainfall. In particular Itchenor pumping station is categorized >3.3% flood risk. But no similar publication appears to exist in relation to Pagham WTW notwithstanding the publication refers to a recommendation to do so.

Wastewater Treatment Process

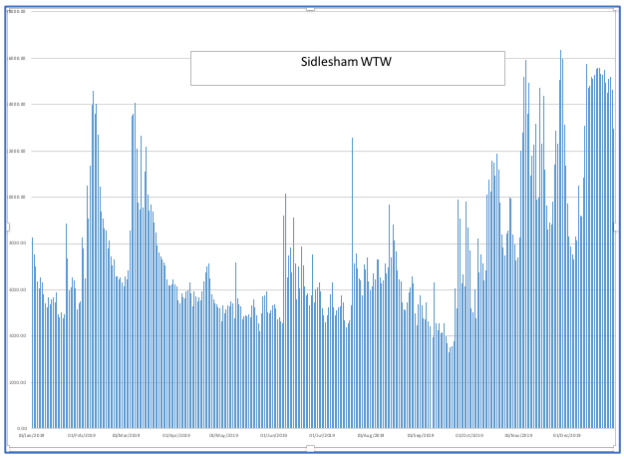
Fig 1. SW Process diagram



Screening: This is the first stage of the process. This stage removes all the things that shouldn't have been put down the toilet pan such plastic bags, nappies, nappy liners, condoms, tampons and all sorts of other stuff and apparently the occasional wallet or mobile phone by all accounts. The list is long. These are caught and cleared by a large steel sieve.
Storm Tank and Combined Sewer Overflow is likely located next on the line to stabilise any high volume of wastewater and control the flow rate.
Primary settlement: This is where heavy particulates such as dirt, grit and solids are allowed to settle (and oils and fats float) and the sludge that is formed is removed and taken away to be processed to become fertiliser.
Biological treatment: This is where the wastewater is trickled over stones or filters containing 'good bacteria' which attack the 'bad bacteria' and it is agitated and activated by pumping air through the tank.
Final settlement: The water by this time starts to look visibly clean and it goes through a final filtering or settlement stage in what often is called a humous tank to remove the last (small) particulates and this outflow can now be released into the environment. But if this outflow would be into an EA designated 'sensitive' protected area then it is required to go through a further step.
Bacterial removal: This step is only carried out if stipulated by EA. Any residual bacteria still present is sterilised using ultraviolet light, which in fact is also effective on a wider range of other pollutants according to the scientific papers on the subject such as the *'Performance of UK wastewater treatment Works with respect to trace contaminants'* published as a joint paper by Plymouth, Brunel and Cranfield Universities and the UK Water Industry Research centre.
Sludge treatment: The process generates a lot of sludge which is then passed into what is often called digesters where bacteria is again used this time to break down the sludge and from which methane gas and fertilizer is produced.

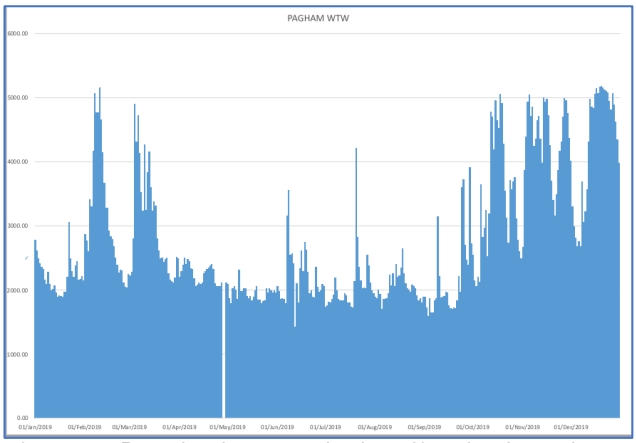
Flow reporting

When first asked about the performance of these WTWs and its process capability SW advised that it didn't actually know the maximum operational capability of each of its WTW's beyond its permit limit and because of the overflow control mechanisms. It said that if it were given a higher EA permit then it would then be able to determine this. It was only learned much later that indeed each WTW had a 'consented' higher DWF permit limit and therefore had a far higher process capability than the author was originally given to understand. It was rather unfortunate that the SW respondent didn't reveal this as it led to very incorrect conclusions in consequence in the first published version of this investigation report. The report had to be recalled.



The graph to the left graphically illustrates the data provided in the SW flow report. This is Sidlesham WTW's reported flow m³ volume for each of 364 days' in 2019. One day is missing from the data report for reasons unknown.

This graph below similarly shows graphically the data points from the Pagham WTW flow report for each of 363 days in 2019. 2 days' data is missing from the data report for reasons unknown. These graphics clearly illustrate the amount of combined wastewater presenting to the treatment works and its variability over a year.



During the course of any typical day householders will demonstrate predictable behavioural patterns. When they wash up, or turn on dishwashers. When they turn on their washing machines. When they have baths or showers. When and where they clean their cars. Even when they decide to go to the toilet. There might be some variation but the volume of wastewater would remain largely stable and consistent from day to day throughout the year.

Adding the proposed additional 1,600 new homes in the Pagham area will generate more wastewater of course and this, as SW originally gave us to believe, remained, within an available headcount of 539m³. But using the now revised 500 l/per day then only 1,078 new dwellings can be supported in the Pagham WTW catchment area.

Rainfall however is an entirely different proposition and clearly very changeable.

The highest spike in the graphs was 20th December 2019 and the daily measured flow at Sidlesham was 15,583m3 and for Pagham 5,181m3. Wastewater and sewage presenting to Sidlesham and Pagham WTW has now been diluted maybe 2+fold, and the rainfall will carry with it additional contaminants washed from agricultural and industrial areas.

Water quality testing

SW extensively sample tests both crude (influent) and processed (effluent) according to the Government Environmental Agency licencing requirements. EA set the sampling requirements and guidelines for the requisite 12 tests per annum. SW is obliged to strictly comply to both Operator Self-Monitoring (OSM) and Urban Waste Water (UWWW) regulation.

The following has been extracted from the SW sampling reports for Sidlesham WTW. Pagham WTW does not sample test as extensively and only those carried out are marked ** are conducted at Pagham. The sampling results for Pagham WTW can be provided separately if required.

Information is taken from the Southern Water process sampling report WTW UWWTD Crude and WRA Final	CRUDE INFLUENT **3/06/2019** FLOW ON DAY 4,749m3 (4.749m litres at 54.97 l/sec average flow rate)	FINAL EFFLUENT **02/06/2019** FLOW ON DAY 5,226m3 (5.226m litres at 60.49 l/sec)
Alkalinity **	-	265 mg/l
Ammonia (Homogenised)**	45.8 mg/l	0.16 mg/l
Average sample temperature **	2.8 deg C	-
Biochemical Oxygen Demand (Homogenised) **	303 mg/l	5.83 mg/l
Cadmium	0.1365 ug/l	<0.07 ug/l
Cadmium DI-3	-	<0.09
Chemical Oxygen Demand (Homogenised) **	667 mg/l	28.8 mg/l
Chloride (Homogenised)	198 mg/l	303 mg/l
Chromium	3.21 ug/l	<0.650
Chromium DI-3	-	<0.9
Conductivity (Homogenised)	1360 USIE/cm	1370 USIE/cm
Copper	97.4 ug/l	8.5 ug/l
Copper Dissolved	-	4.17 ug/l
Iron **	-	0.262 mg/l
Iron (Dissolved) **	-	0.102 mg/l
Lead	4.08 ug/l	<0.27 ug/l
Lead TO-3	-	<0.3 ug/l
Nickel	3.87 ug/l	4.7 ug/l
Nickel TO-3	-	<5.7 ug/l
Nitrate (Homogenised)	<0.02 mg/l	1.68 mg/l
Nitrite (Homogenised)	<0.010 mg/l	0.042 mg/l
Nitrogen (KJELDAHL) (Homogenised)	53.1 mg/l	1.19 mg/l
Nitrogen (Total Oxidised) (Homogenised)	<0.02 mg/l	1.72 mg/l
Number of samples **	48	-
Ortho-Phosphate (Homogenised)	2.63 mg/l	0.624 mg/l
Phosphorus (Total)	8.21 mg/l	0.849 mg/l
Solids Suspended at 105c (Homogenised) **	310 mg/l	3 mg/l
Temperature **	-	18 deg C
Total Nitrogen	53.1 mg/l	2.91 mg/l
Turbidity **	-	4.8 FTU
Zinc	145 ug/l	14.6 ug/l
Zinc (Dissolved)	-	6.38 ug/l

Only those marked ** is carried out at Pagham WTW.

Information is taken from the Southern Water process sampling report WTW UWWTD Crude and WRA Final	CRUDE INFLUENT **16.10.2019** FLOW ON DAY 11,487m3 (11.487m litres at 132.95 l/sec average flow rate)	FINAL EFFLUENT **15/10/2019** FLOW ON DAY 11,571m3 (11.571m litres at 133.92 l/sec flow rate)
Alkalinity **	-	140 mg/l
Ammonia (Homogenised)**	12.5 mg/l	0.928 mg/l
Average sample temperature **	2.8 deg C	1
Biochemical Oxygen Demand (Homogenised) **	48.9 mg/l	2.93 mg/l
Cadmium	0.134 ug/l	<0.07
Cadmium DI-3	-	0.09 ug/l
Chemical Oxygen Demand (Homogenised) **	133 mg/l	28.1 mg/l
Chloride (Homogenised)	224 mg/l	281 mg/l
Chromium	1.72 ug/l	<0.65 ug/l
Chromium DI-3	-	<0.9 ug /l
Conductivity (Homogenised)	1150 USIE/cm	1270 USIE/cm
Copper	25.1 ug/l	5.58 ug/l
Copper Dissolved	-	2.95 ug/l
Iron **	-	0.917 mg/l
Iron (Dissolved) **	-	0.0706 mg/l
Lead	1.55 ug/l	0.616 ug/l
Lead TO-3	-	<0.270 ug/l
Nickel	2.71 ug/l	4.14 ug/l
Nickel TO-3	-	<5.7 ug/l
Nitrate (Homogenised)	0.76 mg/l	5.68 mg/l
Nitrite (Homogenised)	1.09 mg/l	0.032 mg/l
Nitrogen (KJELDAHL) (Homogenised)	12.2 mg/l	<1.00 mg/l
Nitrogen (Total Oxidised) (Homogenised)	1.85 mg/l	5.72 mg/l
Number of samples **	48	-
Ortho-Phosphate (Homogenised)	1.39 mg/l	0.072 mg/l
Phosphorus (Total)	2.25 mg/l	0.357 mg/l
Solids Suspended at 105c (Homogenised) **	53 mg/l	6 mg/l
Temperature **	-	15.9 deg C
Total Nitrogen	14.1 mg/l	5.77 mg/l
Turbidity **	-	5.12 FTU
Zinc	39.6 ug/l	18.9 ug/l
Zinc (Dissolved)	-	6.17 ug/l

Only those marked ** is carried out at Pagham WTW

Strangely the crude sampling data appears to be dated one day later than the final effluent data sample. But as flow amounts are reasonably consistent on day prior / day after, this analysis is more than adequate to illustrate process efficacy.

Some chemicals are added during the process, such as iron, to encourage the settlement to sludge and explains why it only appears in the final effluent sample. Chemical oxygen demand (COD) quantifies the amount of oxidizable pollutants found in surface or wastewater and, thereby, is a determinant of water quality. Biochemical oxygen demand (BOD) reduction is used as a gauge of the effectiveness of the wastewater treatment works process. The process stages work in combination, meaning that each stage doesn't necessarily work in

isolation. While each process can and likely is measured, the important consideration is the crude starting point and the final effluent released into the environment. What we as a community need to understand is what we often throw down the sink, the drain or the toilet pan can often be very challenging to deal with and especially pharmaceuticals. So we need to remember this when we wish to discard an out of date packet of pills as many of these cannot be processed out and will only degrade over time.

The process efficacy (effectiveness) in relation to many sampling components show a substantive and impressive reduction. Ammonia is a good example of this as on the dates in June it was reduced by 99.65%. BOD similarly fell 98.08% and this on the face of it seems to be a very good end result. But I will leave that to the marine biologists and other scientists to determine.

But the process is potentially time and volume sensitive. Meaning the faster the flow rate through the process because of heavy rain fall the less time wastewater has for the settlement of particulates stage, less time for the biological bacterial process to optimise and again less time for the final settlement stage, with this substantially greater volume needing to be handled.

On 02/06/2019 the average flow rate for the day at Sidlesham was 60.49 l/sec and was almost entirely domestic wastewater being at the height of summer. Whereas, on the 15/10/2019 the flow rate was 133.93 l/sec and with a rainfall dilution factor of likely 2.2x. The 15/10/2019 sampling result tells us that Ammonia improved to a slightly lower efficacy at 92.58% to 0.928mg/l. But this of course is measure as a percentage of 1 Litre liquid quantity and means that the total volume (11.571m litres) still contained possibly 10.72 kg of Ammonia (in total) going into the effluent outflow. The 02/06/2019 efficacy with a far lower process volume and flow rate allowed only 0.84kg of total Ammonia to pass through. The same applies to BOD. 33.9kg on 15/10/2019 whereas 20.02kg on 02/06/2019. Whilst in percentage fall terms the process efficacy appears very good, but in reality in gross total absolute amounts pollutants are still getting into the Rife and onwards to the harbour. The author is not an ecologist or scientist, so it is not for me to say what might or might not be the cumulative long-term affect this has to such a supposedly protected environment.

Environment Agency only sample tests bathing water quality at beach level and does not it appears carry out any sampling whatsoever within the Pagham Harbour, probably on account this harbour is not designated a 'sensitive' area and we are not allowed to swim in it. EA test for Escherichia Coli [EC] and Intestinal Enterococci. [IE] at beach locations all along the Hampshire, Sussex and Kent coast 1st May through to 1st October and their findings are reported on the internet for all to see. During 2016 through to 2019 EA was sampling on a weekly basis. This was suspended of course during COVID-19 lockdown in 2020 and not reinstated until back end of July 2020 and was only tested on one day in July (27th), one day in August (18th) and one day in September (10th). Thereafter no EA beach testing will take place until May 2021…presumably on the basis that few if any go swimming at other times of the year.

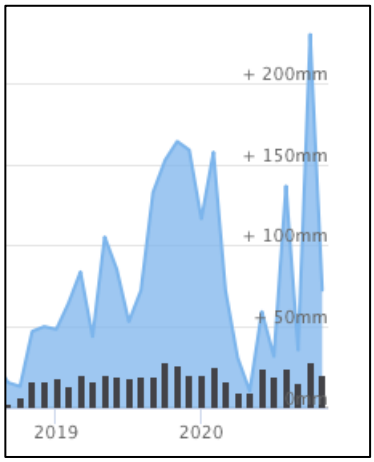
It is noted that on the 24th April 2015 EA did publish some Benthic Bi Intertidal testing results but this testing seems to have been a one-off exercise and never repeated. Benthic Bi Intertidal sampling is usually carried out to monitor microeukaryotes organisms in sediment in intertidal zones and which are essential to the ecosystem and will reflect environment change. The University of Brighton is still running such a study of Pagham Harbour through to 2025.

Pagham Rife. Date not known

The EA report for 18th August 2020 is notable. There likely occurred on this date, or shortly before it, a massive release of untreated wastewater / sewage somewhere, and maybe even partly or wholly from Pagham Harbour.

EA at 12.15pm on 18th August at Pagham Beach recorded EC 45x acceptable limit and IE 74x acceptable limit. Abnormal samples were also noted at Bognor Regis, Felpham and Middleton-on-sea and so on all along the coast eastwards. This was the only date in August on which EA conducted sample testing. Pagham Beach EA sample results for whole of 2017, 2018 and 2019 are largely 'normal' throughout and while there is recorded a few instances in 2019 which are slightly up but not higher than 9x, 6x or 7x permitted values, nothing like this 45x or 74x not safe to swim-in result has previously occurred. It is noted that Bognor Regis (Aldwick) result was substantially higher, but it is not clear yet whether this was the bloom of effluent moving eastwards or simultaneous spills occurring all along the coast.

Selsey, to the west of Pagham Harbour however recorded absolutely normal levels for both EC and IE on that date. As coastal tidal flow and wind direction is usually west to east along the south coast, and as the Selsey beach sample in fact is reported to be perfectly and absolutely normal, then the only possible conclusion is that it was Pagham Harbour (partially or wholly) and attributable to an exceptionally large untreated wastewater/sewage spill having occurred. The graph to the right is rainfall up to end of November taken from the internet and is specific for Bognor Regis shows a huge and unusual spike in rainfall. A question then arises that if it was 45x and 74x acceptable limit at beach level after being substantially diluted in the open sea, then what exactly might have been a sample result within Pagham Harbour itself.



SW water sampling results were available at time of this report including 18th Aug 2020, and again this is the only SW sampling date in August, and this looks okay to the author based on comparison with prior sample results. Unfortunately, though, SW flow and especially spill reports are unlikely to be available until early 2021, but we can probably guess already what this will tell us. SW were given opportunity to comment upon this event but little was forthcoming.

Chemical Filters & UV equipment

UV is used to kill bacteria and performs in the same way as a garden pond filter with a UV light. It destroys Escherichia Coli and Intestinal Enterococci which causes eye and ear infections and gastro-intestinal illnesses and the higher the level the more hazardous it is to humans

and wildlife alike. Exposure to untreated sewage or its products can also result in Weil's Disease, Hepatitis, jaundice, respiratory difficulty and asthma, and in severe cases possibly allergic alveolitis. But research suggests that UV is effective in a much wider range of pollutants that remain otherwise in the effluent outflow from WTWs.

Chichester Harbour is used extensively for water recreation and leisure purposes (boating, canoeing, fishing, swimming etc) and is therefore extensively tested for EC and IE by Chichester District Council ['CDC'] as it has this EA 'sensitive area' designation. CDC tests at 11 specific locations consistently on the 1st and 3rd week of every month 12 months a year and the sampling reports have remained normal for 2020 YTD August and throughout the whole of 2019. Normal means <10 particles per 100ml for each of EC and IC. The designated sampling locations are: Thorney Island Sailing Club slipway; Cobnor Dinghy Park Slipway; Bosham Quay; Dell Quay; Chichester Sailing Club slipway; Itchenor Jetty; North of Dell Quay; Chichester Marina Beacon; Deep End Bodham Channel; Emsworth Jetty; East Head. Nonetheless, SW in collaboration with CDC are building a new 10 km wastewater pipe connection from Chichester to Tangmere WTW and is due to be completed by end of 2025.

Pagham and Sidlesham WTW does not possess any chemical filtration or UV capability. SW confirm that they are investigating currently the possibility of installing Nitrate filtration maybe by 2025, but confirms that they have no plans at this time of installing UV 'disinfecting' equipment at these works as it is not an EA designated 'sensitive' area.

The absence of ultraviolet equipment is potentially very important and Chichester Harbour is a clear example of how important this might be. Chichester Harbour has advantage over Pagham Harbour in both water critical mass and the fact that of the 3 WTWs releasing effluent in to the Chichester Harbour 2 works have full UV 'disinfecting' capability which it is understood they apply to both treated and storm water overflows. Over the reporting period 2017-2019 there were 35 Chichester reported spills. 9 came from localised combined sewer overflows (CSOs), but of the 26 spills reported at its WTWs 20 (77%) were fully 'disinfected' by UV.

SuDs limitations

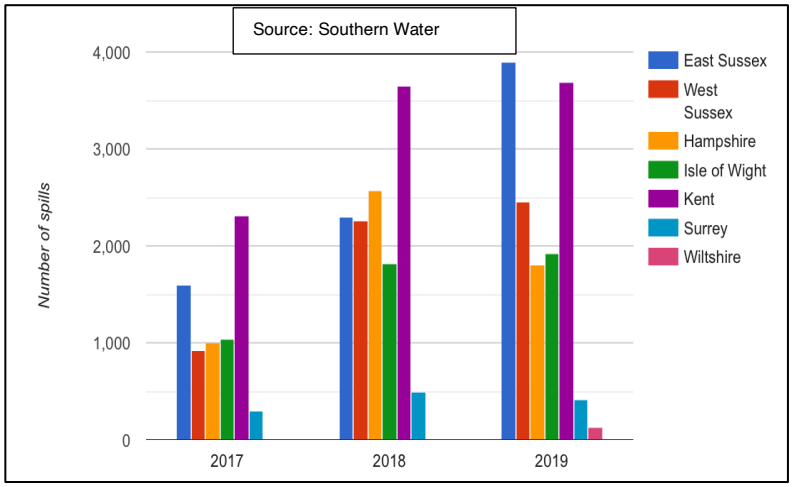
SW in its publicly available materials recognises the important role of SuDs, but admits that new builds using SuDs will not necessarily eliminate storm water from getting into the wastewater systems if these are overwhelmed and/or have not been maintained adequately and flooding arises to the point where groundwater reaches combined drains, gullies or sewers and infiltrates into the flow leading to the wastewater treatment works. Apparently, they are very effective when the development is first new, but SW report that these gradually deteriorate and this is why they now use 500 litres per day wastewater per average household for the purposes on planning, rather than the factor 336.8 l/day advised previously.

SW also expressed concern of what they describe as 'urban creep' whereupon permeable land is being increasingly consumed and lost through overbuilding with new houses, roads, paths, patios and drives, whereupon a diminishing amount of rainwater is being allowed to naturally dissipate. SW is also concerned for premises using private cesspits for which they have no control or responsibility. These too they say could flood out and result in cross contamination/infiltration.

This rather comical photograph showing someone sailing a dinghy (with a rudder and centre board!) on a usually dry Sefter farming field was posted on general circulation 2019 showing flooding on an area of land where outline approval has been granted to build 300 houses and a care home. The point is well made however that this will need a substantially large SuDs, but once covered in urban creep and the SuDs maybe is full and/or poorly maintained, then this water will need to go somewhere else. Can we be absolutely certain this will not just cause flooding to reappear, or correspondingly increase, somewhere else?

Spill reporting

'Spill' data is readily available on line from the SW official web site and has been since 2017, either in the form of colour charts as is presented here in this section or in excel spreadsheet format for all WTWs, CSOs and pipe networks in SW locations.



This chart illustrates just how many spills are actually occurring each year in West Sussex and neighbouring counties. The figure for West Sussex for 2019 was 2,456 total spill incidents. The highest bar relates to East Sussex with 3,893 spills. This chart of course quantifies how many incidents were reported, but not necessarily over how many hours or days it had occurred or what volume was released.

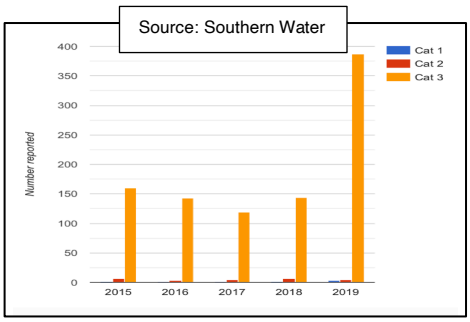
Remember that a spill of untreated sewage and wastewater occurs if a pipe bursts, a pumping station fails, or when the storm tank is full and the flow rate continues to exceed the Combined Sewer Overflow control which is 201 litres/sec for Sidlesham and 59 litres/sec for Pagham.

From the official SW 'Spill' reports you will see 4 classes of spill. 'Emergency' and likely meaning something broke and there was am urgent need to contain the release of untreated. 'Disinfected' meaning passing through ultra-violet treated before release (but only Chichester seems to have this capability). 'Settled Storm' meaning it (momentarily) passed through the storm containment tank and then straight out because the tank was full. 'Storm' and likely meaning totally untreated bypassing the entire process and directly into the environment. Depending on the storm tank design and therefore its

effectiveness in negating flow turbulence, heavy particles will to some extent also 'settle' in this tank and can therefore be considered as only partially processed

Spills are categorized according to the following designations. Mostly these are Cat 3, but it is not known how many or how frequently a sequence or series of Cat 3 events eventually equal a Cat 1.

- **Category 1** incidents have a **serious**, extensive or persistent impact on the environment, people or property
- **Category 2** incidents have a lesser, yet **significant**, impact
- **Category 3** incidents have a **minor** or minimal impact on the environment, people or property with only a limited or localised effect on water quality
- **Self-reported** - where we (ie. SW) report an incident to the Environment Agency before it's reported by a third party, it's also recorded as a 'self-reported incident'.



The following Table provides reported spills 2017-2019 for Sidlesham WTW and Pagham WTW from the SW sourced excel data report.

	2017				2018				2019			
Location	Date	Time	Spill Hours	Flow m³	Date	Time	Spill Hours	Flow m³	Date	Time	Spill hours	Flow m³
Sidlesham WTW	-	-	-		-	-	-		06/02/2019	23.17	43.02	11,380
									04/03/2019	09.53	18.26	13,530
									12/03/2019	14.56	5.70	11,115
									20/7/2019	02.48	4.42	12,579
									24/09/2019	08.44	3,57	9,886
									29/09/2019	10.48	6.20	9,797
									11/10/2019	23.02	84.02	6,862
									02/11/2019	14.50	5.60	12,023
									04/11/2019	10.26	27.67	15,211
									07/11/2019	02.13	1.33	14,950
									9/11/2019	15.51	2,88	11,783
									13/11/2019	22.54	17.49	9,973
									25/11/2019	13.38	51.83	15,080
									12/12/2019	14.20	266.21	13,080
Pagham WTW (North Mundham WPS)	11/10/2017*	20.39	0.77	-	-	-	-		22/12/2019	15.11	0.45	5,125
	21/10/2017*	08.18	1.48									
Pagham WTW	12/01/2017	17.36	6.11	3,377	01/01/2018	01.05	3.42	5,017	07/02/2019	01.13	45.08	2,770
	31/01/2017	18.26	8.96	4,372	04/01/2018	06.12	3.96	4,883	04/03/2019	06.08	11.75	4,900
	27/02/2017	04.09	12.71	4,895	16/01/2018	11.41	1.51	4,857	20/07/2019	08.38	0.39	4,216
	02/08/2017	16.46	10.07	3,365	22/01/2018	10.55	76.02	5,096	12/10/2019	20.29	60.74	4,781
	27/12/2017	08.47	4.50	4,034	14/02/2018	20.09	25.23	3,846	02/11/2019	18.25	43.54	3,870
	29/12/2017	08.47	17.67	4,037	08/03/2018	01.14	81.43	5,005	09/11/2019	17.23	12.94	4,358
					15/03/2018	10.25	24.38	4,877	13/11/2019	23.14	60.92	3,976
					30/03/2018	13.59	121.51	4,760	26/11/2019	16.20	54.22	4,704
					10/04/2018	02.56	13.05	4,930	12/12/2019	16.34	306.76	4,311
					26/08/2018	16.37	7.54	3,539				
					15/10/2018	09.59	2.39	4,141				
					19/11/2018	19.09	4.49	?504*				
					01/12/2018	11.12	28.53	4,406				
					07/12/2018	10.32	11.15					
					15/12/2018	16.41	204.70					
			62.27				609.31				1,134.54	

** Classified 'Storm'. All others reported are classified 'Settled Storm'.

SW spill reports are only readily available from 2017, but what we have is sufficient to demonstrate that Pagham WTW has a pattern of long-term and likely increasing incidence of spills. There is nothing reported in the SW spill reports for Sidlesham WTW in 2017 and 2018 so either something dramatic changed back end of 2018 or there is a 'blip' in the reporting.

The Combined Sewage Overflow is a protective measure. If the flow rate substantially increases because of heavy rainfall then over the CSO setting the wastewater is diverted to a storm tank. When the flow settles then wastewater is returned from the storm tank(s) back into the normal process. Only if the storm tank is totally full and the rate of flow continues to exceed the CSO parameter does a 'spill' occur with unprocessed wastewater being released in to the Rife. But while it remains in this storm tank part of the 1st stage process does actually begin where larger particles start to settle and are screened out depending on the level of flow turbulence.

Extensive influent (in) and effluent (out) sampling is conducted and reported, flow is reported, CSO mechanisms with a flow rate per second control is in place, date and time a spill starts and ends is reported, and also the duration of a spill. But SW does not however record or report total volume released as this, apparently, is not a requirement under the Event Duration Monitoring regulations. But because this is not monitored / reported then we can only hypothesize as to how much might have been be released.

Spills are nonetheless openly and honestly self-reported by SW and the days of its 'difficulties' are now consigned to history. If the reader is interested you can go to the SW web site and learn what its new Chief Executive (since 2017) says as their/his plans, promises, undertakings, guiding principles and corporate goals and objectives going forward. The general public can also report a spill on its hotline 0330 303 0368 (option3) or via the EA national hotline 0800 807060.

But what is important to understand is that in the event of a spill only a portion of wastewater / sewage is released. The following Table attempts to provide a (rough but realistic) estimate of likely unprocessed effluent release during a spill on an assumed basis of 1 Litre, or 5

Litres or 10 Litres per second duration. It will of course be variable, but this gives us some indication of best case and maybe worse-case scenario in the absence of knowing precisely the volumes released.

	Dilution factor	Spill time (hours)	Estimated Effluent volume released (2019)					
			1 litre /sec (Total volume)	1 litre /sec (Untreated))	5 litre /sec (Total volume)	5 litre /sec (Untreated)	10 l/sec (Total volume)	10 l/sec (untreated)
Sidlesham	2.4	538.20	1,937m3 (1.937 million litres)	807.45 m3 (41.67%) (0.807 million litres)	9,782m3 (9.782 million litres)	4,035m3 (41,67%) (4.035 million litres)	19,564m3 (19.564 million litres)	8,070m3 (41.67%) (8.07 million litres)
Pagham	2.2	596.34	2,146m3 (2.146 million litres)	975.83 m3 (45.47%) (0.9758 million litres)	10,734m3 (10.734 million litres)	4,880m3 (45.47%) (4.881 million litres)	21,468m3 (21.268 million litres)	9,760m3 (45.47%) (9.76 million litres)

Dilution factor is derived from total flow on the reported day of spill (averaged) divided by (averaged) wastewater volume taken from a dry month (May 2019) and net of the highest 9 rainfall days in that month.

The purpose of this table is solely to provide some reasonably sound perspective of what a spill means so far as wastewater/sewage is concerned. The point being emphasised is that only a proportion of what is 'spilled' is actual unprocessed (or only partially processed) wastewater / sewage, and the basis upon which the dilution factor has been determined if anything gives a more favourable outcome. Heavy rainfall of course will bring with it other pollutants washed from agricultural land and industries in the area (directly or through infiltration) which would be additional and can, to a certain extent, be observed in the influent/effluent sampling results. If applied to the total spills reported solely for West Sussex, e.g. 2,456 spills in 2019, the total number of hours of combined duration of spills is reported by SW to have been 24,168 hours not including Chichester spills that were UV 'disinfected'. On this basis, and assuming a 41.67% proportion of wastewater, then 1 litre/second means 36.25 million litres, at 5 litres/sec means 181.27 million litres and at 10 litres/sec means 362.54 million litres of unprocessed or only partially processed wastewater getting into waterways and onwards to outflows to the sea.

Earlier in this report we explored the efficacy of the wastewater treatment process and the before (influent) and after (effluent) sampling results. A point to emphasise is that the 'spill' is crude influent. Meaning it contains the level and concentrations of 'influent' chemicals and pollutants from which it is possible to (approximately) calculate the weight and mass of. There are 1,000 milligrams in a gram. There are 1,000 grams in a kilogram. Do the maths.

I am sure there is a very scientific term for the following, but I will call it the 'Surge Affect' ['SA']. This is where a contrary force changes the characteristics of a spill. Members of the public do not carry around with them scientific equipment and can only react to what they see and what they smell. If they can see it and smell it then some individuals will report it. And it could well be that on those occasions they in fact are observing this surge effect.

During the course of a typical day we humans bath, shower, toilet, put on the washing machine or dishwasher and pour all sorts of things down the kitchen sink in a fairly consistent and predictable way. At night we sleep. If it rains and rains constantly and unvaryingly during a whole 24 hours then this just evenly dilutes the daily wastewater flow. Whatever goes into the system likely takes a few hours usually before it reaches the WTW.

But if it rains heavily and only during the night when we are asleep then what goes into the combined sewer system will be very little wastewater and mostly rainwater. If the rain comes down in a torrent then it will have a surge effect and it will push and force at a faster rate everything that was already in the system, and maybe way too much for the CSO and storm tank and therefore, a higher concentration of untreated effluent could conceivably go into the Rife. If though, this torrent occurs perhaps at 7am in the morning, then this surge of cleaner rain water could get in the way of the normal daily human wastewater, but it is unlikely to impact the wastewater coming later unless the CSO control continues to be exceeded.

A further added complication are the tidal cycles in the harbour. Pagham Harbour does not entirely empty when the tide goes out so anything abnormal would not necessarily be fully 'flushed' out on a single cycle. When the tide is incoming it will also backflow and hold back any effluent outflow up to and including the Rife. But if this is happening at the exact same time as a spill occurs then a bloom of wastewater / sewage likely becomes likely very visible. If we were to overlay meteorological data, tidal cycles data, and flow and spill data, we will likely, maybe, be able to observe exactly what happened, when and why.

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Conclusion(s)

The revelation that the supposedly protected Pagham Harbour SPA and SSSI does not have a 'sensitive' Environment Agency or Natural England designation and therefore doesn't warrant the full wastewater treatment protocol including UV comes as a bit of a shock. Admittedly it sits very close to the sea, and is tidal. But the treated effluent (and especially untreated influent) released goes into an inland waterway (a Rife) and then passes through a site that has just about every environmental and ecological protected label you can think of, yet is still not designated a 'sensitive' area in the same manner as Chichester Harbour or other similarly protected sites. If it were to be, then the additional 'disinfecting' stage would greatly improve the effluent quality released into this protected harbour, and especially in relation to unprocessed spills that frequently occur.

The issues are not unique to Pagham Harbour. To a lesser or greater extent this is happening at most if not all wastewater treatment works throughout the country judging by the press and from the official SW spill data which is available on most if not all wastewater treatment works in this region. Most, but not all, pollutants are removed by the process and which we may expect to see becoming increasingly compromised by changing weather pattern and in adding more influent through new housing developments.

Most of these WTWs were built decades ago, and undoubtedly by visionaries and has stood the test of time well. Upgrades have been carried out and also there has been vast improvements in the science to it. But the processing of wastewater cannot remove every trace of pollutants, and yet we users continue to present challenges to the water treatment companies in demanding ever higher standards whilst still pouring lots and lots of things down the drain, down the sink, down the toilet that we perhaps shouldn't. Notwithstanding the well-publicised history of 'difficulties', the wastewater treatment companies are undoubtedly doing as best they can to handle what we, the user,

and the climate, throw at them and what comes out only contains a portion of what goes in. That's the fact of it. Nonetheless, there is growing concern as to what still gets released into the environment and the impact of more and more houses adding to the mix.

The process is volume sensitive. The faster the rate of flow of wastewater through the process the lower the efficacy of what comes out at the end. The effluent values may still be substantively minimalised, and is a credit to the process. But the gross weight and accumulating chemical concentrations undoubtedly has long-term ecological implications on the receiving waters and needs to be considered very seriously.

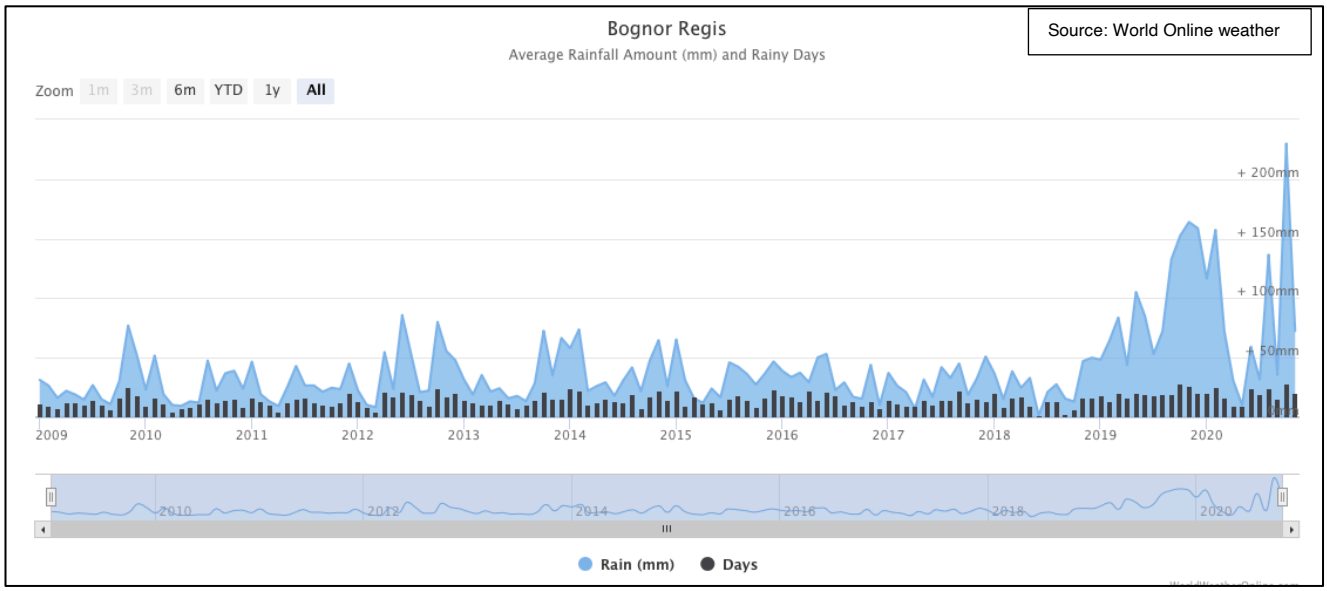
We learn that Southern Water has difficulties presently with its pipe network and needs 24 months to put this in order for the Pagham WTW. Will this then, possibly, enable a new setting on the Combined Sewer Overflow rate of flow control so that the now frequently occurring 'spills' would be eliminated or at least substantially reduced? Southern Water does not actually know (because apparently it is not required to measure) what the flow rate is during a spill, and only knows when and how much time duration. A best-case scenario is 1 Litre per second which in 2019 means 4,083,000 litres of unprocessed or only partial processed wastewater was released in to Pagham Harbour. But as we don't know the exact volume we cannot rule out the possibility that in fact it was maybe as high as 10 litres per second which would be 40,852,000 litres. But let us settle on maybe a compromise and a more sensible mid-point of 5 litres per second and an effluent outflow of 20,516,000 litres of which possibly 42-46% was untreated or only partially processed wastewater effluent. The figure that Southern Water came up with as a worse-case scenario assuming 6xDWF for Sidlesham and 4xDWF for Pagham is actually a total of 144,694m3 (144,694,000 litres) of settled storm water outflow going in to Pagham Harbour but they did emphasise that would be an extreme situation.

Department of Housing, Communities & Local Government keep beating the drum of 'build, build, build' and using all sorts of stick and carrot methods to get county and district councils to deliver on specified housing targets using, arguably, a flawed methodology in determining how many and where, and is now proposing a fundamental overhaul of the planning approval process in an attempt to quicken the pace even though there is a significant number already consented and approved yet sitting in developers' land banks. Almost simultaneously the Department of Environment, Food & Rural Affairs is banging on about 'protect, protect, protect' and has put forward a new Environment Bill likely involving what it describes to be a protracted process of debate, deliberation, and consultation and we can expect likely fraught as usual with inter-party point scoring and internal posturing, and there is no obvious evidence that these Departments have any joined-up or collaborative thinking. But do we not already know what immediate steps we can (and should) take without another long-hall study before anything meaningful likely emerges. A possible issue arising from 'stick and a carrot' methods is how this can both positively and unfortunately sometimes negatively influence behaviours where goals and objectives become embedded into collective or individual performance assessments at all levels of the organisation and where increasingly some aspect of a role or important duties can become a secondary consideration. Points mean prizes by delivering on the goals and not for finding reasons not to do so. That is the whole purpose of setting goals and then aligning employee assessment methods, but sometimes it has consequences. An example of this might be members of a planning approvals Committee or a senior Officer of a district council stating that it is not their problem nor responsibility to concern themselves with wastewater handling as Southern Water are legally obliged to deliver whatever is necessary to support the Local Plan, and that there should be no further debate on the subject. But if they knew then, and certainly know now, that such infrastructure is not currently capable yet they still push to hit the target, then they are indeed absolutely responsible and held accountable for the consequences.

The author is not against building new houses. The fact of the matter is we do need to provide for our population who need homes to live in, but are we really thinking it through sufficiently intelligently. My point is that we need to think carefully where housing needs to be built. Think carefully about the imperative of ensuring the fabric of the infrastructure can facilitate it where they are to be built. If it is to be otherwise, then so be it, let's disregard the consequences and for good measure just right off Pagham Harbour and not delude ourselves the environment is worth protecting.

On the point of local district councils, we know from Southern Water that it has problems with its pipe network and needs 24 months to deal with this. Meantime, if a developer is in a rush to make profit (and district council urgently wishing to get some points on the scoreboard), the developer can proceed on the basis they construct huge sub-ground wastewater storage chambers, adoptable pipe network and pumping stations and then tanker away the wastewater to one of the receiving works until these can be allowed to connect to the public system. P/58/15/OUT Summer Lane for 90 dwellings is already in progress and at groundwork stage and it looks at the moment a bit like a battlefield. The developer has in plan to go this route of using tankers and if Southern Water at the end of 24 months is not ready then Southern Water admit it thereafter becomes their problem. Pagham WTW is in fact only 500 metres further down this narrow Summer Lane, but instead of waiting for the pipework to be upgraded the developer and district council are happy to proceed on this basis. P/25/17/OUT for 65 further dwellings only 600 metres distant could also kick-off soon and by all accounts the only access and exit will again be Summer Lane (emphasis on lane). Meantime, a large number of 20-40+ ton HGVs and equipment are currently daily passing existing houses within only 3 or 5 metres to do the groundwork and to be followed in due course by building material. At the end of all this and likely before SW is ready they will use tankers short or long-term which brings with it environmental and highways concerns. P/58/15/OUT with 90 dwellings when occupied will generate 30.2m^3 (30,200 Litres) of daily wastewater. A small wastewater tanker can carry 8,000 Litres (1,759 gals), a medium sized can carry 16,000 L (3,519 gals) and a really big one can carry 20,000 Litres (4,399 gals). How many tankers a day does this make? Answers on a postcard please to Arun District Council with copy to the Environment Agency. Now add to that 65 possible additional dwellings under P/25/17/OUT bringing the daily wastewater generated up to maybe 52.2m^3 (52,200 Litres).

Finally, take a look as the next graph. This comes from the Worldwide Online Weather site and is specific to Bognor Regis, and even the SW official web site provides a graph illustrating the same for 2020.



The number of days it rained each year from 2009 has remained fairly steady and is represented by the black vertical pins. The blue pattern is rainfall. It has rumbled along fairly consistently since 2009 but then jumps incredibly in 2019 and into 2020. If this is what we can continue to expect going forward then we have every reason to be concerned about building on coastal flood plains and whether infrastructure is fit for purpose

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v3.0 18th December 2020

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