PROVIDING A SOLUTION TO THE BRIDGWATER WEST UIDS

Anthony Raine - Pell Frischmann Consultants
Rob Henderson - Wessex Water

1.0 Introduction

Approximately £55 million was spent by WW during AMP3 on Unsatisfactory Intermittent Discharges (UIDs) throughout their region, to improve both river and bathing water quality, with over 520 being either improved to a satisfactory standard and consented or eliminated. Six CSOs in the west area of Bridgwater were identified in the Wessex Water UID programme:

- Blake Gardens PS
- Chilton Street (Saltlands) PS
- Taunton Road PS
- West Quay Drawbridge PS
- Wembdon Common PS
- Enmore Road Reservoir PS

One of the drivers for this scheme was the need to ensure continuing compliance with EU bathing water standards at the Burnham beaches close to the mouth of the River Parrett, before the regulatory deadline of 31st March 2005. Since 1988 the bathing water at Burnham-on-Sea has consistently met the Mandatory EU Bathing Water Standard. It is widely recognised that achievement of the Guideline value is very challenging in the waters of the Severn Estuary, but lower background bacteria levels from reduced operation of storm overflows will help move towards this aspiration.

2.0 Study Catchment

Bridgwater is situated on the North Somerset (Sedgemoor) Levels astride the River Parrett about 30 miles southwest of Bristol with a population of approximately 28,000. The topography is mainly level, with large areas of land drained by a system of canals, dykes and ditches, some dating back to medieval times.

Most of the recent residential development within the catchment dates from the post war period and surrounds the town centre. Larger council estates dating from the 1960's were built in the north along with further estates in the 1970's in the south. Private housing developments continued in the south, west and northwest areas throughout the 1970's, 80's and 90's and still continue at the present time. Figure 1 provides a map of the catchment showing the location of the UIDs.

Coinciding with the fastest period of residential development, the Bridgwater West Bank Sewerage Scheme was constructed in the early 1970's to intercept old combined sewerage outfalls discharging directly to the River Parrett. This scheme involved the construction of 4 large pumping stations delivering flow from the trunk sewers sequentially northwards towards Chilton Trinity STW.

Sewage from catchments on the east bank of the River Parrett is also pumped to Chilton Trinity STW, but these flows are not hydraulically linked to Bridgwater West.

The nearest designated Bathing Waters are at Burnham Jetty, 2 km to the northeast of the mouth of the River Parrett estuary and some 21km downstream from central Bridgwater. The river receives direct intermittent discharges from 11 CSOs as well as continuous discharges from two wastewater treatment plants, namely Chilton Trinity and West Hunstpill STW. Since 2000, both works have provided UV treatment to their continuous discharges.

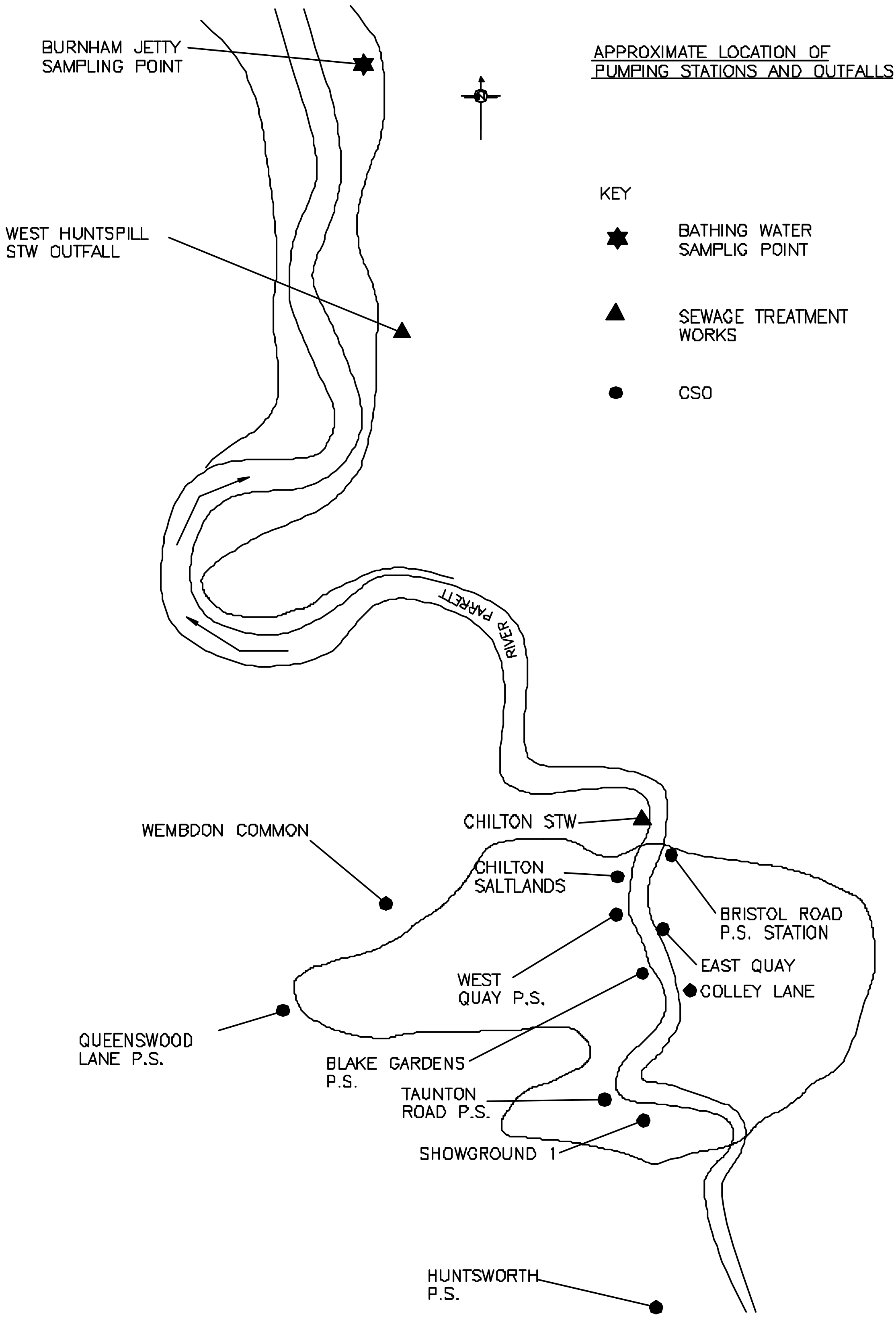


Figure 1 – Plan Of Showing River Parrett Estuary With Locations of Catchment Area, UIDs, STWs & EA Sampling Point

3.0 Identification Of UIDs

The UIDs were agreed by the EA, based on perceived impact and with reference to performance data provided by Wessex Water prior to the start of the AMP3 period. CSO performance prior to the scheme is summarised in Section 7.0.

4.0 Data Collection

The existing hydraulic model, sewer records, historical telemetry data, as-built drawings, existing impermeable area plans and drainage area plan were collected and reviewed to assess the scope of additional survey requirements.

The need for the following surveys was identified and these were undertaken as part of the Bridgwater West UID scheme:-

- Detailed surveys of the UIDs.
- Dimensional surveys and drop tests on all pumping stations.
- Surveys of other CSOs and bifurcations.
- CCTV surveys to locate infiltration & structural \ service defects.
- Connectivity and level surveys at selected locations.
- Short-term flow surveys.
- Detailed topographic surveys at UID sites.

The following problems were encountered during the various surveys:-

- Operational problems at various pumping stations.
- Lack of detailed survey information due to the inability to safely carry out man-entry surveys at key PS sites, largely due to inadequate access.
- Large localised deposits of silt in sewers.
- Observed depths at gauged locations often fell below the minimum depth required for accurate flow measurement.
- Velocities at gauged locations downstream of pumping stations often exceeded the maximum velocity required for accurate flow measurement.

5.0 Modelling

The original model was verified as part of the Bridgwater West DAP in 1992. Due to large-scale new development in Bridgwater since the original DAP and the simplified nature of the existing model there was a need to enhance and re-verify the model. A verification attempt was made using limited survey information in 2001 but this proved to be impossible due to the lack of information and operational problems at the main PS sites. The scheme was subsequently deferred and revisited in 2002 using a comprehensive flow survey and following some operational and access improvements at the pumping stations.

The model was updated utilising the Wastewater Generator tool within InfoWorks to replicate diurnal dry weather flow patterns. The depth data observed on dry days was used in conjunction with as-built drawings to help establish pump rates during the survey period. These pump rates were then used with the pump runtime data to establish typical dry weather flow volumes at the pumping stations. Different diurnal profiles mimicking the pattern of dry weather flow during weekdays and weekends were created, based upon observed flow monitor responses. Some monitors did not operate as well in dry weather as they did during storms, due to velocities and depths falling below measurable limits.

No significant tidal inflow was observed during the flow survey period, either in dry weather or during storm events. The overflow at West Quay Drawbridge PS did however become surcharged, when tide levels rose above the outfall flap valve. At these points the storm pumps turned on for very short periods of time.

The New UK run-off model was applied to several contributing sub-catchment areas to simulate attenuated run-off from large pervious areas. However, a substantial delayed rural inflow observed upstream of Taunton Road PS was represented in the model using a series of large storage ponds, with an overflow from the final pond to the combined sewerage system. Large permeable contributing areas with high run-off routing values were assigned to these storage ponds which resulted in them overflowing for long periods of time. Orifices were modelled at the base of each storage pond draining at a limited rate to freely discharging outfalls allowing them to drain down after each storm. The weir coefficients and orifice limiting discharges were calibrated to produce favourable comparisons between observed and model predicted flows. This method was adopted as opposed to using the infiltration module in InfoWorks, as it was considered simpler to calibrate within the tight programme available. Also, despite several surveys to locate the source of the problem, the true cause or exact location was never identified. It is possible that one of the many dykes which drain surface water runoff was diverting flow into the combined system when it became hydraulically overloaded perhaps via an undetected connection or structural deficiency in the private or public combined sewer network.

A number of pumping stations serving new developments upstream of Taunton Road PS, were originally intended to be foul sewage only pumping stations but telemetry data indicated that pumps at several of these PSs pumped much longer during rainfall events. This came as quite a surprise and highlights a challenge for the water industry to put pressure on local planning authorities to ensure surface water separation is maintained in both new and existing housing developments.

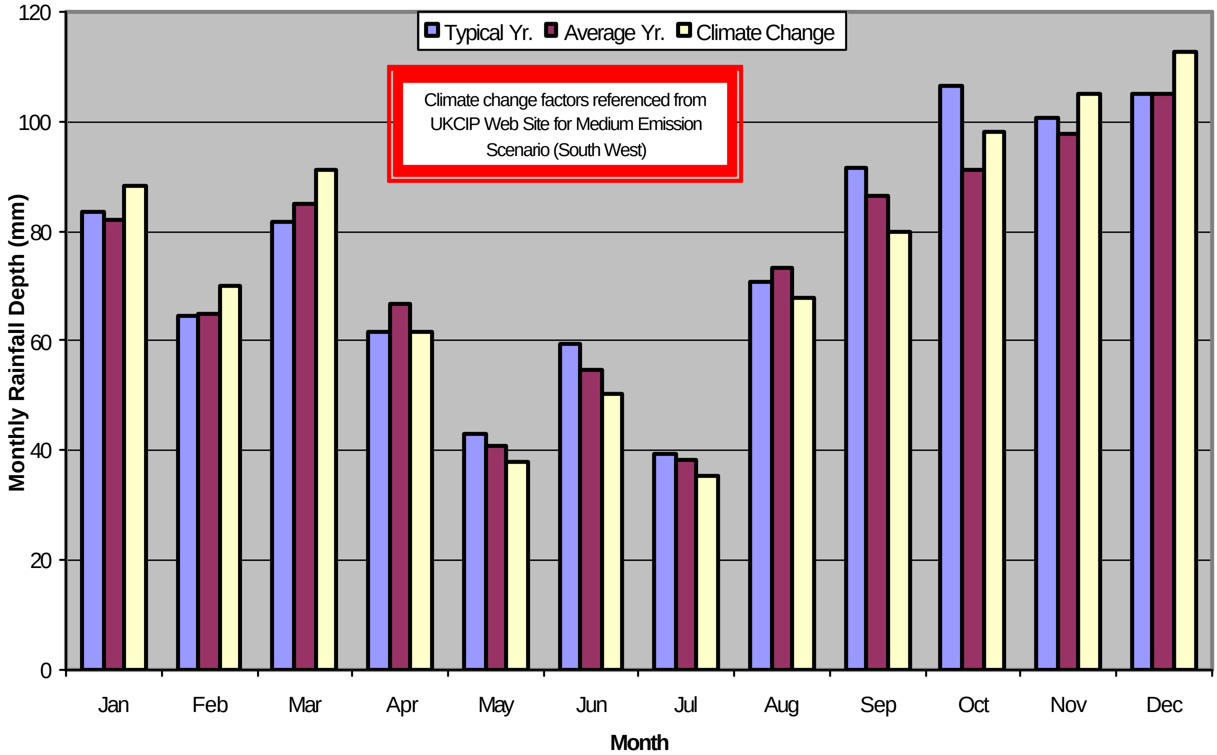
Real time control was applied to the model to reflect variations in pump performance observed at several of the PSs during the flow survey periods.

Considering the problems with the flow monitors and the physical aspects of the catchment, the verification results were considered reasonable.

6.0 Existing System Performance

In order to reduce the simulation time of various option model runs, a typical year was derived from the 10 year time series data set produced by Stormpac using local historic rainfall data. These compared well with average monthly figures for the South West Region taking into account climate change. Figure 2 below illustrates the comparison between the derived typical monthly rainfall, the average monthly rainfall and the projected monthly rainfall taking into account climate change. The latest guidance from the UKCIP website was used at the time of the analysis.

Figure 2 - Comparison of Average and Typical Year Rainfall. Including Climate Change Allowance.



The table below provides a summary of the model predicted CSO spill performance for the existing system.

UID	Bathing Season (BS) Performance			Annual Performance	
	Nr. of Spills	Spill Duration (as% of BS)	Total Vol. (m^3)	Nr. of Spills	Total Vol. (m^3)
Taunton Road PS CSO	9	0.17	7,680	34	51,000
Blake Gardens PS CSO	15	0.41	8,190	49	35,000
West Quay PS CSO	38	1.69	33,046	89	107,000
Saltlands PS CSO	34	1.70	36,550	84	133,000
Wembdon Common PS CSO	0	0	0	0	0

The modelled results corresponded reasonably well with telemetry data for the 2002 and 2003 Bathing Seasons in terms of spill frequency after account was taken of the below-average rainfall in both of these Bathing Seasons.

7.0 Dispersion Analysis

An assessment of impact on bathing waters was carried out in 7 steps:-

Step 1 – Identifty sources of bacterial pollution into the River Parrett ie. CSOs & STWs
Step 2 – Determine spill frequencies, volumes and BOD load from CSOs (An existing model of the Bridgwater East catchment was combined with the West to predict these)
Step 3 – Determine bacterial quality of storm sewage and UV treated final effluent from STWs

Step 4 – Produce a dispersion model using an existing tracer study and indicator organism die-off values
Step 5 – Test sensitivity of dispersion model by varying the input parameters
Step 6 – Estimate E.coli concentrations on the bathing water
Step 7 – Compare dispersion model results with relevant standards

An existing tracer study determined the minimum available dilution downstream of Chilton Trinity and West Huntspill STWs. It incorporated two surveys carried out over a neap and a spring tide and revealed the following:-

- The neap tide excursion was insufficient to allow indicators to reach Burnham Bay from Chilton Trinity STW.
- The spring tide excursion allowed indicators to reach Burnham Jetty in high dilution.

This study also assumed that negligible indicator organism die-off occurred before impacting on the Bathing Water.

The dispersion model was used to estimate bathing water bacteria concentration for each spill event predicted by InfoWorks and continuous discharge from both STWs. As the tracer studies were only carried out during neap and spring tides, the dispersion model sets each spill to occur on a neap and spring tide which gives the two extremes of the model results. Thus, the presumed average was taken to be half of the spring tide results.

The dispersion model results were verified against field sampling data and the study concluded the following:-

- Sampling data for the period of 1999-2002 indicated that Burnham Jetty was compliant with the mandatory standard with the exception of two failures which were not related to storm events. The dispersion model supported this finding.
- In comparison with the guideline standard, the predicted results of the dispersion model were not representative of field sampling data. Average guideline standard compliance was 26% and 76% for field sampling data and model predicted data respectively. It is believed that this is mainly because the dispersion model only predicts pollution caused by the CSOs and the STWs. The level of pollutant measured at Burnham by the EA is clearly influenced by other pollution sources, principally from agricultural sources and surface water runoff. Achievement of Guideline standard could not, in practice, be achieved by tackling wastewater discharges alone.

8.0 Evaluation Of Improvement Options

The study concluded that achievement of Mandatory standard of Bathing Water compliance could be routinely achieved without provision of additional storage. A “3 spills per Bathing Season” solution would provide little practical benefit and indeed construction of the massive storage volumes required to meet this target would be impractical and very disruptive to the local community and the local environment. In discussion with the EA it was agreed that the most appropriate improvement solution would be one which provided a performance significantly better than Formula A at the design horizon and which included 6mm screening to conform with AMP3 guidelines.

Given constraints at certain points within the trunk sewer system it was clear that a solution which provided the required performance could not be achieved by upgrading pumping stations alone; it would be necessary to provide additional storage to provide equivalent performance (in terms of spill frequency and volume) whilst keeping pass-forward rates similar to existing. The exception to this was West Quay pumping station, where the pragmatic agreement was to provide as much storage as practicable within the boundary of the existing PS site in order to reduce the spills as much as possible from this UID. This UID was known to spill more frequently than the others and was in a much more visible locality.

Option models were tested by simulating them with the same typical rainfall year used to assess system performance, with the longer 10-year series being simulated periodically when time allowed, to ensure that solutions were still fully Formula A compliant at the design horizon.

Site constraints were taken into account at this early stage. These included the limited amount of space available for storage at Blake Gardens PS (due to site topography and proximity to a pedestrian subway) and West Quay PS (due to surrounding development proposals). Tanks therefore needed to be offline and deep, as online tank sewers would be impractical in roads and would not have provided enough storage. The catchment next to the river is relatively flat, therefore any stored storm flow needed to be returned to the sewerage system by further off-line pumping. The interaction of the pumping stations also had to be accounted for, since any changes at one would almost certainly affect the next PS downstream. Any options involving increasing pump forward rates from any of the PSs were rejected due to the potential risk of increased flooding downstream.

To minimise storage needed at Blake Gardens PS, it was considered economical to use a telemetry link with Taunton Road PS upstream to control the pass forward flow rate, together with a larger storage tank at Taunton Road, where much more space was available. A lengthy iterative process ensured each PS UID achieved performance in excess of Formula A. Following a review and modelling of several options the following final solution was identified:-

- Maintain existing pump rates
- Provide storage locally at each PS to achieve design horizon Formula A equivalent CSO spill performance with the exception of West Quay where the maximum amount of storage will be provided within the existing site boundary, providing enhanced performance.
  The following storage requirements were required to achieve this:-
    - 2,350 m^3 of storage at Taunton Road
    - 100 m^3 of storage at Blake Gardens
    - 300 m^3 of storage at West Quay
    - 1,500 m^3 of storage at Saltlands
- Inhibit Taunton Road PS when Blake Gardens sump level is high
- Provide emergency generators at Taunton Road, Blake Gardens, West Quay and Saltlands PS's
- Provide fine screens at all UIDs

9.0 Construction, Post Scheme Appraisal & Conclusion

The two largest tanks, at Taunton Road and Saltlands are shafts of 25m and 17m diameter and 9m and 13m depth respectively. Work on all of the sites has been subject to Bridgwater's notoriously poor ground conditions, due to the fact that much is built on land reclaimed from the sea. Three of the shafts were constructed using cutting rings, with each section being jacked down one ring at a time. The largest tank was constructed by undermining and then constructing each ring below the previous one.

To minimize the risk of odour complaints and operational problems, mixers were installed in the four tanks to keep solids in suspension. Ventilation ductwork was also installed to allow for retrofit of odour control units at a later date if this proves necessary however to date no odour problems have been notified.

Examination of telemetry has revealed that the system is performing well and that it is reassuring that the real world is behaving much as required by the model! Spill occurrences are well within the predicted frequencies and this is partly due to the drier than average summer and also the fact that model predictions assumed dry weather flows to the design horizon, 20 years hence, plus of course the simulated rainfalls made some allowance for climate change.

UID	Model Prediction Pre-scheme No of Spills per BS	Model Prediction (Post-scheme average over 10 years, flows at design horizon)		Actual 2005 Bathing Season (Post-scheme – from telemetry)	
		No of Spills per BS	Spill Duration (as % of BS)	No of Spills per BS	Spill Duration (as % of BS)
Taunton Road PS CSO	9	2	0.30	0	0
Blake Gardens PS CSO	15	5	0.09	1	<0.01
West Quay PS CSO	38	17	0.80	12	0.50
Saltlands PS CSO	34	8	0.21	5	0.69 *
Wembdon Common PS CSO	0	0	0	0	0

* Extreme wet weather at the end of June (remember the Glastonbury weekend mud!) was responsible for the single longest spill at all sites and this event impacted most on the terminal pumping station at Saltlands, causing prolonged spill there.

Telemetry results are being reviewed to further optimize operation of the pumping stations as it appears that there is scope for making fuller use of the storage at Taunton Road, with the benefit of reduced spill at West Quay and Saltlands

Review of the 2005 Bathing Water sampling results for Burnham has been somewhat inconclusive. As with all such series of data there is considerable scatter, with higher bacterial counts tending to follow wet weather, but not always so. The bathing water fell well within compliance of the Mandatory standard with 50% of the samples achieving Guideline standard. This does seem to be a slight improvement on previous years but there is no step change in improvement, consistent with the background bacterial level being around the Guideline value due to remote discharges and non-wastewater sources.

Bathing Season (s)	Percentage of samples meeting BWD Guideline standard for…		
	Faecal Coliforms	Total Coliforms	Faecal Streptococci
2000 -2004 incl (pre-scheme)	33%	68%	64%
2005	50%	75%	70%

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