MODELLING REVERSE FLOW THROUGH A STORM OVERFLOW

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Introduction

The inability of WASSP-SIM to model reverse flow through a storm overflow has caused several problems when trying to analyse catchments in which the sewer receiving spill discharge from a storm overflow, becomes surcharged to a higher level than the water level in the storm overflow chamber. In such a case the storm overflow ceases to spill as discussed in an earlier paper.*1

This paper outlines a procedure which can be used to simulate reverse flow through a storm overflow and gives examples of cases where this has been done.

The Problem

The layout of a typical storm overflow is shown in Fig. No. 1 with the corresponding hydrographs for a 1 in 2 year storm detailed in Fig. No. 4. It can be seen in Fig. No. 4 that when the level in surface water sewer (18.010) exceeds that in the combined sewer (1.350) the discharge hydrograph for the storm overflow spill is turned off and no further transfer of water takes place between the two systems.

A Solution

To overcome this problem a notional storm overflow can be placed on the surface water sewer downstream of the connection from the actual storm overflow, care being taken to observe normal rules for pipe length, dia. etc. to prevent oscillation in the results.

The weir level of this notional storm overflow should be set slightly higher than the water level which turned off the spill from actual storm overflow on the previous run. The notional connection pipe for the spill from the notional storm overflow should be connected back into the combined sewer downstream of the actual storm overflow.

Example:- Storm Overflow in a Pipeline

This procedure was used on a catchment which had eight storm overflows in a combined sewer spilling to a surface water sewer, refer to Fig. No. 5. By adopting this model it was necessary to re-order the SSD file, a three stage data ordering chart is given to assist in this end. Typical hydrograph results for the actual and notional storm overflowsare illustrated in Figs. No. 6A and 6B. These show that the hydrograph peaks in each of the pipes, at each end of the storm overflows, coincide. The depth values have been added to pipe data to give water levels related to ordnance datum, and these can be seen alongside the pipe nomenclature.

The Results

By comparing the difference in peak water level valuesfor the sewers and storm overflow spill branch, on Figs. No. 6A and 6B it can seen that even though the water level in the surface water sewer adjacent to the actual storm overflow is higher than that in the storm overflow, no reverse flow takes place. However, the notional storm overflow spills into the combined sewer relieving the surface water sewer.

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1 Experience with Storm Overflows
R. Chaplin - WaPUG Autumn Meeting 5th November, 1985

Example:- Storm Overflow in a Pumping Station

A WASSP-SIM analysis of existing sewers in a catchment outfalling to a pumping station showed flooding in a section of the catchment, which from local knowledge, was known not to occur. An appraisal of the WASSP data revealed a deficiency in the modelling of the pumping station.

Pumping Station Layout

The pumping station was designed to deal with combined sewage and its basic layout is shown in Fig. No. 7. The sewage entered the station via a stilling pond storm overflow, normal flows passing forward to a sewage wet well with storm flows being diverted to a storm wet well.

The original model of the station is shown in Fig. No. 8. The results from WASSP-SIM showed high water levels in the sewage well, corresponding to the flood levels in the catchment, and lower levels in the storm well. An inspection of the pumping station drawing showed that there were in fact three routes the flow could take to enter the storm wet well.

(i) Over the actual stilling pond weir;

(ii) over an emergency weir set to protect the storm overflow screen if it became blocked;

(iii) over a suspended walkway common to both wet wells.

It was the third point which triggered the need to model reverse flow because if sewage could flow into the storm wet well over the suspended walkway, obviously the converse was also possible. A revised model of the pumping station was produced and is shown in Fig. No. 9.

The respective water levels from the WASSP results in the inlet channel, sewage well and storm well are shown in Fig. No. 10 for a range of three storms. It is the results of the 50 year storm which are particularly interesting, because in the other two storms no significant spill over the suspended walkway took place. However, in the 50 year storm it can be seen that at time 40 minutes the sewage well starts to spill over the walkway and fill the storm well. From time 60 minutes the wells are filling at almost the same rate and by time 80 minutes the water level in the two wells equals that in the inlet channel from then on the water levels rise concurrently.

The results obtained using this model produced no flooding in the aforementioned area of the catchment.

Conclusion

By careful inspeciton of the model and with intimate knowledge of the actual sewerage system it is possible to introduce notional storm overflows into the model thereby allowing assessment of maximum surcharge levels caused by reverse flow through storm overflows.

FIG Nº 1. PIPEWORK LAYOUT.

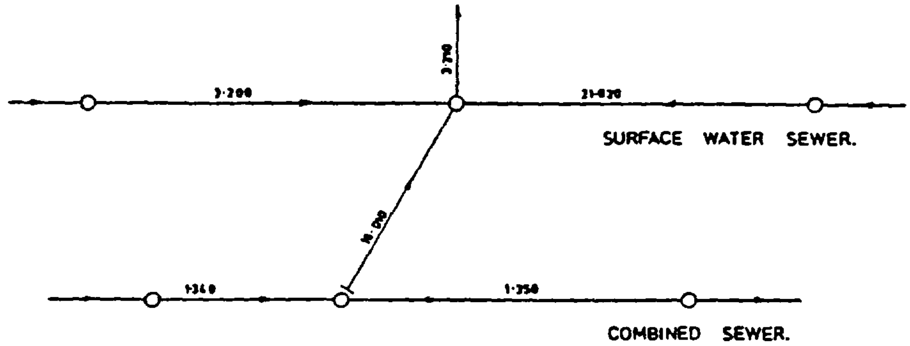
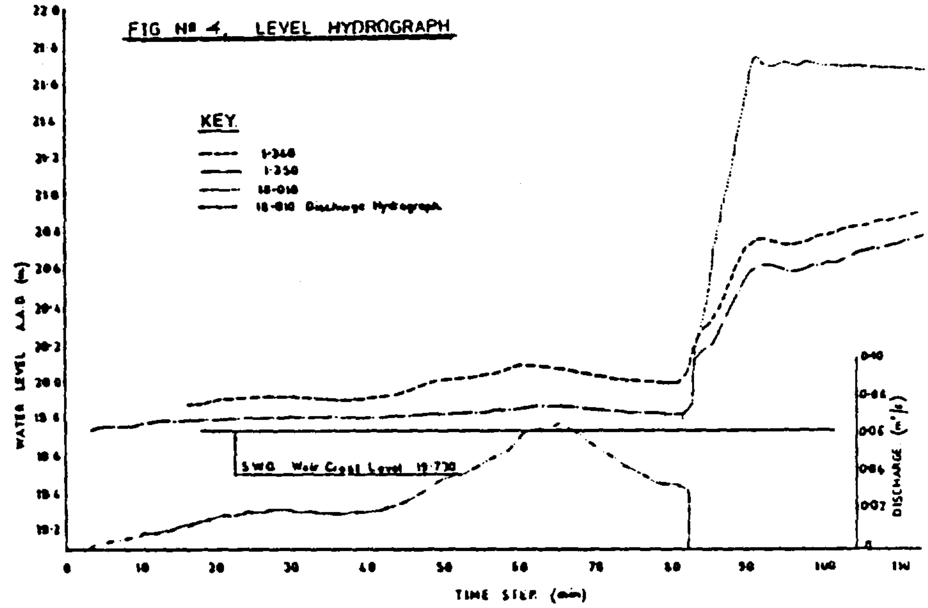
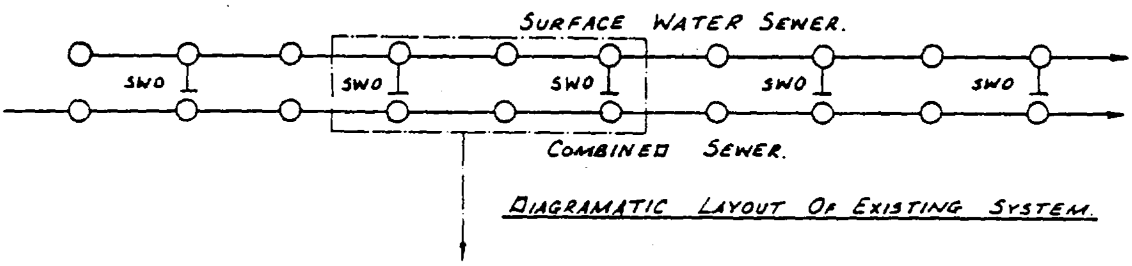


FIG Nº 4. LEVEL HYDROGRAPH





DIAGRAMATIC LAYOUT OF EXISTING SYSTEM.

MODEL FOR WASSP.

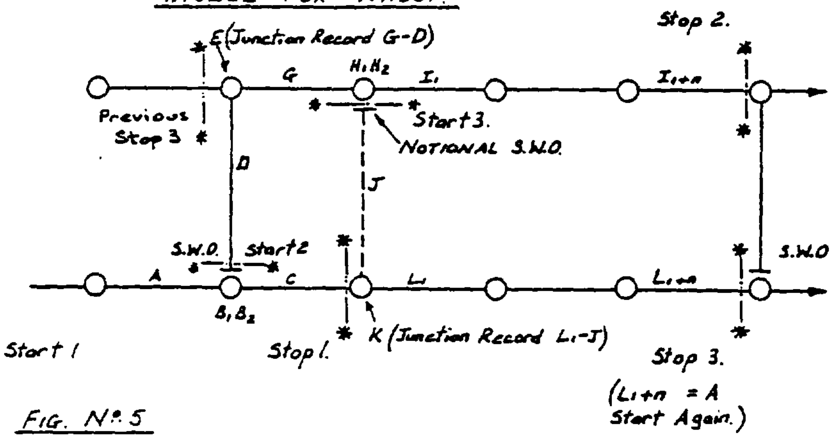


FIG. Nº 5
TO SIMULATE REVERSE FLOW THROUGH A S.W.O. TO OBTAIN SURCHARGE LEVELS ONLY.

DATA ORDERING.

STAGE Nº	FEATURE	RECORD Nº
1	A	4
	B_1	9
	B_2	10
	C	4
2	D	4
	E	7
	G	4
	H_1	9
	H_2	10
	$I_1 \rightarrow I_{1+n}$	4
3	J	4
	K	7
	$L_1 \rightarrow L_{1+n}$	4

EXAMPLE OF REVERSE FLOW THROUGH A S.W.O.

2 YEAR DESIGN EVENT WITH 120 MIN DURATION.

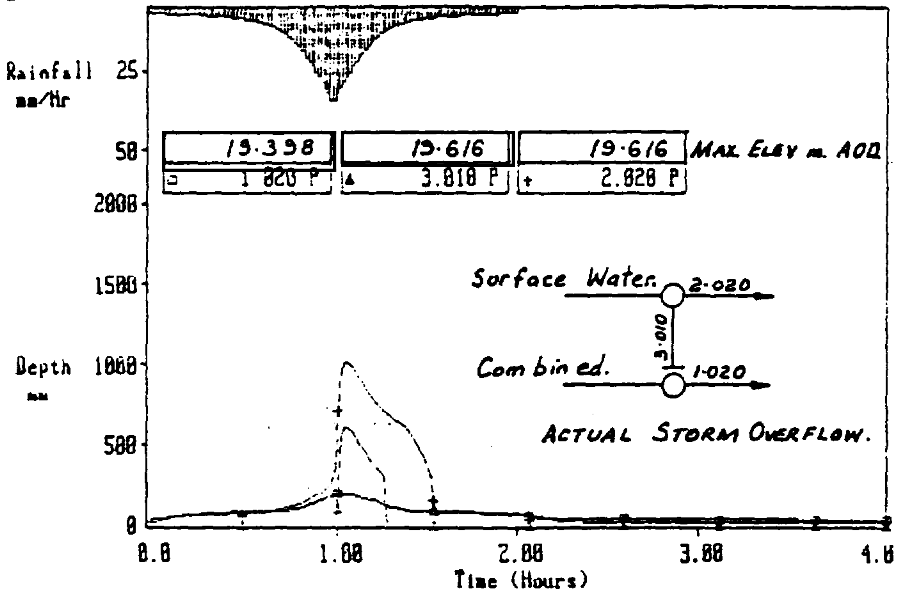


Fig. Nº 6A.

Depth Hydrograph At The Actual Storm Overflow.

EXAMPLE OF REVERSE FLOW THROUGH A S.W.O.

2 YEAR DESIGN EVENT WITH 120 MIN DURATION.

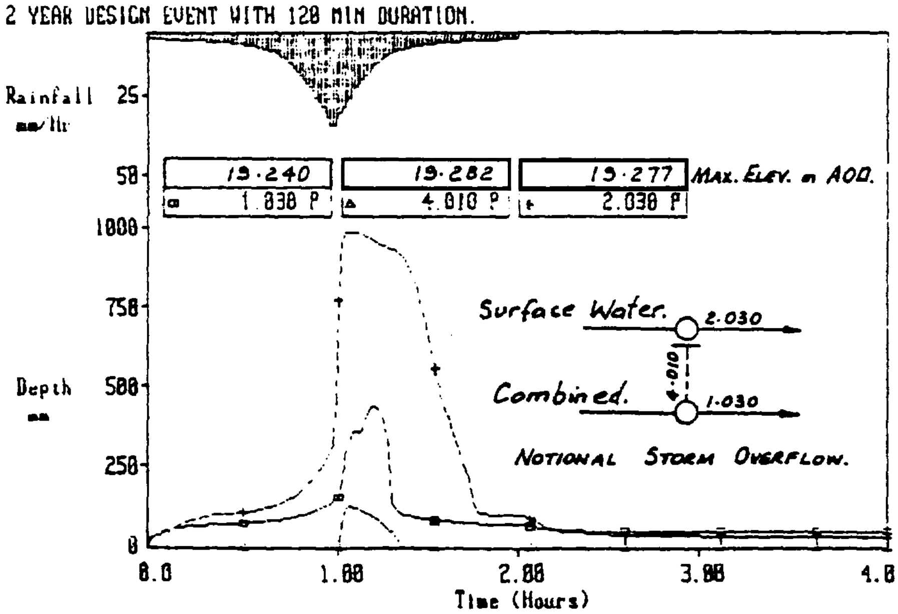


Fig Nº 6B.

Depth Hydrograph At The Notional Storm Overflow.

FIG. Nº 7.

PART PLAN OF PUMPING STATION.

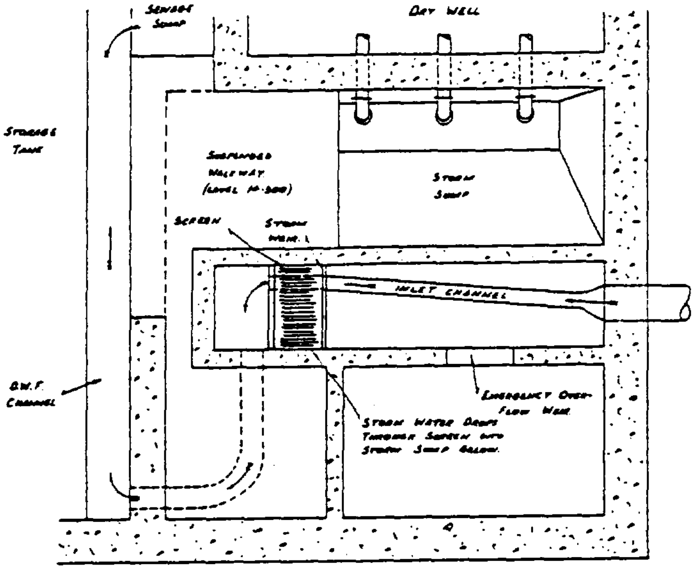


FIG. Nº 9.

REVISED CONFIGURATION OF PUMPING STATION

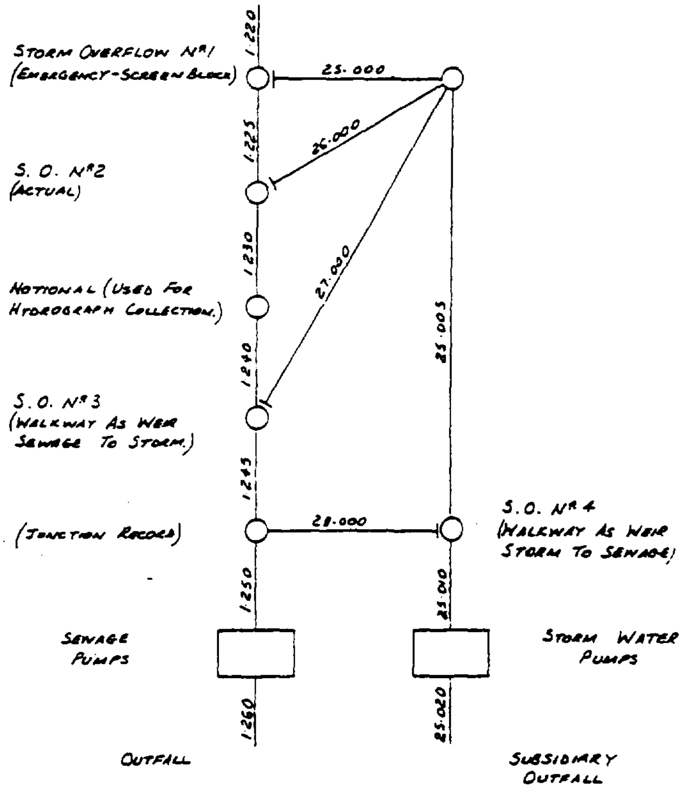


FIG. Nº 8.

CONVENTIONAL LAYOUT OF PUMPING STATION.

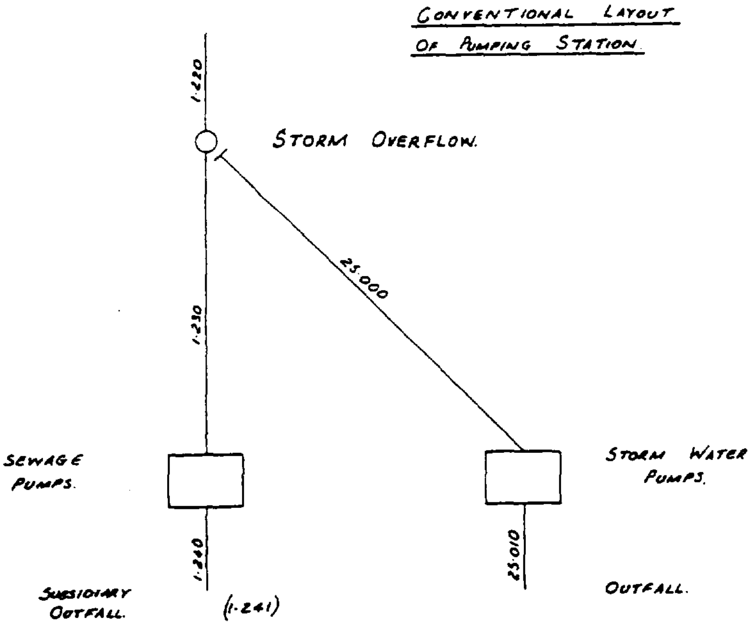
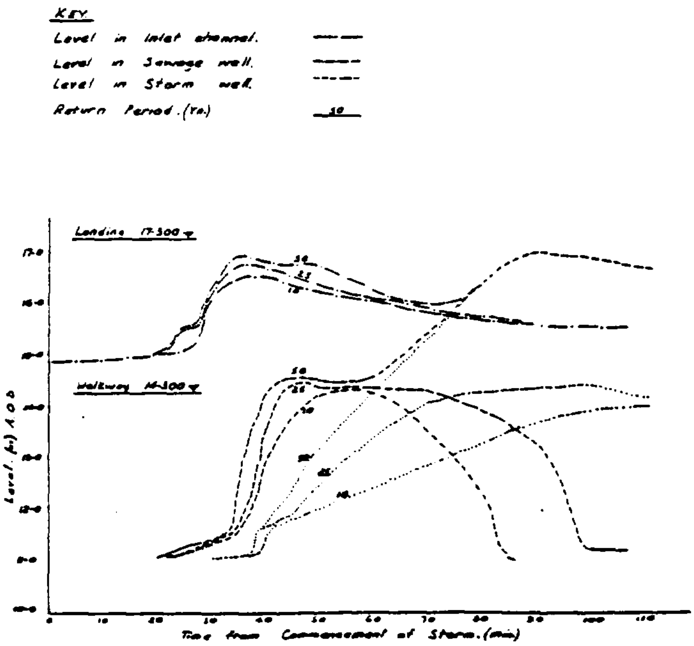


FIG Nº 10.

LEVEL HYDROGRAPHS WITHIN PUMPING STATION.



Discussion on Mr. Chaplins' presentation

P. Graham, Allerdale D.C.

What were the criteria for sizing the overflow pipes?

R. Chaplin,

They were generally oversized and of sufficient length not to cause oscillations.

D. Walters, Bolton M.B.C.

Tried a similar approach to this type of problem in Bolton early in 1985, but experienced difficulties when modelled flows in the main sewer fell below the input D.W.F.

R. Chapman, W.R.C.

The loss of D.W.F. in the main sewer was probably due to a fault in the software at that time. The fault, known as the eroding weir problem, has now been eradicated.