COBBINS BROOK

ONDA MODEL

INVESTIGATION OF FLOOD FLOWS AND LEVELS

FULL REPORT

Hydraulic Modelling Section
National Rivers Authority, Thames Region
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ENVIRONMENT AGENCY
102115

CONTENTS

1. SUMMARY

Flood alleviation channel improvements were carried out along the Cobbins brook in the urbanised area of Waltham Abbey in 1979. Serious flooding occurred on 29/7/87 and there have been two bank-full events since then.

It was decided to use the mathematical model, ONDA, to 1) evaluate the existing channel capacity, 2) assess the increase in channel capacity obtained by a) raising banks b) constructing a by-pass pipe, c) widening the channel, and d) dredging d/s of the 1979 scheme, 3) evaluate the maximum discharge of all structures, 4) investigate the afflux of the flume, 5) evaluate the capacity of the Honey brook tributary and 6) re-estimate the peak flow for the 29/07/87 event.

There was no in-bank flow/level calibration data available at the start of the study. Water level recorders were installed during the study and hopefully useful proving data will be forthcoming in the near future to confirm the results and conclusions.

During the study it emerged that the flume appeared to drown at high in-bank flows.

The main results of the study were that existing channel capacity is 17 cumecs along Broomstick Hall Road. With a very large by-pass pipe the capacity can be increased to 21 cumecs. By widening the channel by 2m the capacity can be increased to 26 cumecs. The maximum discharges under the road bridges were found to be 26 cumecs at Parklands, 26 cumecs at Broomstick Hall Road and 24 cumecs at Honey Lane. (Maximum discharge is defined as the discharge for which flow just u/s is bank-full.)

It would appear therefore that in order to contain the 50 year return period target level of protection of 28.9 cumecs in an environmentally and economically acceptable way a combination of measures will be needed including upstream storage and raising bank heights.

2. INTRODUCTION

2.1 Study Authorization

A "Cobbins Brook Catchment Study/Flood Plain Review" was initiated in a hydrology request form by John Meekings and Mike Pomfrett on 22/8/88. The problem as stated in the form was "catchment model needed for appraisal of possible flood alleviation works" in the Waltham Abbey area. Date required by 1990. When the hydrology study was completed the hydraulic modelling study began, in September 1989, using the hydrology flow results as input to the model.

2.2 The Problem

A flood alleviation scheme of channel improvements was carried out in Waltham Abbey in 1979. Serious flooding occurred on 29/7/87 and there have been two bank-full events since then. It was decided to re-estimate the desired flood flow to be conveyed (part of the hydrology study) and to evaluate the existing channel capacity and the increase in capacity gained by channel improvements (the hydraulic modelling study).

2.3 Previous Work

The hydraulic capacity of the constructed scheme was investigated by Steve Webster in a post-scheme review. The results indicated that channel capacity was less than previously thought.

2.4 ONDA Model

The ONDA model was an available in-house tool which could be used for steady capacity flow runs and also for the unsteady flood flow of 29/7/89 - a useful calibration event as 23 flood levels were available. A summary report of the hydraulic modelling study with results and conclusions was circulated on 23 November 1989.

2.5 Terms of Reference

The terms of reference for the study in the order they were given are set out below:-

1. Re-estimate peak flood flow for 29/7/87 event using an unsteady out-of-bank model. Compare model w/l results with recorded flood levels.

   Starting level at flood channel = 16.76m A.O.D.N.
   Water depth through M25 culvert = 0.3m below soffit level

   Assumed approximate peak flood flow between 35-40 cumecs

2. Steady in-bank model runs to establish existing channel capacity (maximum in-bank flow) up to Galley Hill Rd (nodes 1048-1001 - see map).

3. Investigate channel capacity with the following conditions:-

a) Flume removed
b) Pipe crossings and footbridges removed. (Applies to obstacles which could be easily raised or re-routed).

4. Find out where and by how much bank heights need to be raised in order to contain the following flows:-

a)	30 year return period -	25.8 cumecs
b)	50 " " "	28.9 "
c)	100 " " "	34.1 "
d)	50 " " " with u/s storage (50ST)	26.9

5. Evaluate the maximum discharge at all structures/obstructions. The maximum discharge condition for a structure is defined as the discharge for which flow just u/s is bank full.

6. a) Estimate channel capacity with a by-pass pipe/culvert running down Eastbrook Rd. Investigate two options:-

i) 1.35m dia. concrete pipe
ii) 3m wide x 2m deep concrete box culvert

Pipe/culvert entry between old survey cross-sections 43-42 and invert level at channel bed level - 19.35m A.O.D.N.

Pipe/culvert exit between old survey cross-sections 24-23 and invert level at channel bed level - 18.39m A.O.D.N.

b) With the by-pass option find out by how much bank heights need to be raised to contain the 30, 50 and 100 year return period flows given in point 4.

7. Build an in-bank model of Honey brook and assess channel capacity.

8. a) Estimate channel capacity with a wider channel. Investigate two options:-

i) channel from flume u/s to Paternoster Hill (nodes 1048-3) widened by 1m.
ii) channel widened by 2m

b) With the widened channel find out by how much bank heights need to be raised to contain the 30, 50 and 50ST year return period flows.

9. a) Estimate channel capacity with the channel bed between the d/s end of the 1979 scheme down to the flume (nodes 18-3) dredged/lowered by 0.5m

b) With the dredged channel find out by how much bank heights need to be raised to contain the 30, 50 and 50ST year return period flows.

3. DATA

3.1 Survey Data

A new survey, comprising a long section and cross-sections, was carried out. Two short stretches were not surveyed as the data from a previous survey was available. Two additional spot level surveys were carried out. The first one concerned storage area levels and the second garden and d.p.c. levels around the Cobbins/Honey confluence.

3.2 Hydrological Data

The results of the FRQSIM hydrological study provided the Cobbins and Honey flow input hydrographs to ONDA for the 30, 50 and 100 year flood events. For other steady flows the Cobbins/Honey split was estimated to be Cobbins 88% and Honey 12%.

3.3 Flood Level Data

23 flood levels for the 29/07/87 flood event were provided. The levels showed a large variation across the width of the envelope and a couple of levels were assumed to be outliers.

3.4 Other Information

The river was visited and photographed. Projects staff are not aware of there being any significant blockages during the 29/7/87 event.

4. MODEL STRUCTURE

This section describes how the ONDA model has been applied to the Cobbins brook.

4.1 Hydraulic Boundaries

To re-estimate the 29/7/87 event the out-of-bank model boundaries were chosen u/s and d/s of the flood envelope ie. u/s of Paternoster Hill Nursery down to Larsen Rec. (nodes 1048-14). The tailwater level was assumed to be bankfull.

For the in-bank steady "channel capacity" model runs the area of interest ran from node 1048 down to the confluence of Cobbins brook with the Ramney Marsh flood relief channel (node 1001). The tailwater level was assumed to be the highest level recorded during the 29/7/87 event (conservative assumption). Because the catchment is steep, about 1:330, backwater effects soon die out, therefore tailwater starting levels are not critical.

4.2 Flow inputs

For the unsteady out-of-bank model full flow hydrographs for Cobbins and Honey brooks were used. The Cobbins and Honey hydrographs for a combined peak of 33.3 cumecs were provided by the hydrology study. These hydrographs were amended to give hydrographs with combined peaks between 35-40 cumecs. The Honey hydrograph ordinates were all shifted forward by 1/2 an hour to maintain coincident peaks in the model.

For the steady in-bank model a flow in the Cobbins brook d/s of the confluence was assumed to be split 88% Cobbins and 12% Honey u/s of the confluence.

4.3 Types of Model

Two models were constructed - an out-of-bank model with flood plain flow units (cob3.dat) and an in-bank model of the channel (whole6.dat). If the computed w/ls in the in-bank model rise above bank-full ONDA builds vertical walls simulating a raising of banks improvement option. Node connectivity diagrams showing how model units have been connected together to represent structures, river reaches and floodplains are presented in Appendix A.

4.4 History of Model Development

First an out-of-bank model was constructed from nodes 1048-14. An in-bank steady-state model was then constructed from the d/s face of the M25 culvert down to the flood relief channel (nodes 1022-1001). This model was used to compute the channel roughness. Next an in-bank model was built of the whole developed area (nodes 1048-1001). The Q:H Control Unit employed to model the modular rating at the flume (at this stage assumed to be valid over the whole range) was found to automatically drown because of high tailwater levels giving a non-modular rating. It was decided to split the model in two using the flume rating as the tailwater boundary in the upper model and passing the flow through as the u/s boundary in the lower model.

When the upper model was run with the flume removed as part of the flume afflux investigation it was shown that for a particular flow the w/l d/s of the flume position was higher than the level given by the modular rating u/s of the flume. Clearly, therefore, the flume drowns and a non-modular flow occurs.

Because the flow range of interest is in the high "drowned" area it was decided to model the flume by removing it since when the flume is very drowned it effectively is having no influence on the flow - as if it were not there.

An in-bank model of the whole area was reconstituted with the flume removed.

The models which were all progressed iteratively are listed below:-

1. Cob3.dat - unsteady, out-of-bank, fixed/known tailwater
2. Whole6.dat - steady, in-bank, conservative 29/07/89 flood channel level assumed for tailwater.
3. Whole11.dat - same as whole6.dat but with dredging option
4. Whole13.dat - same as whole6.dat but with 1m channel widening option
5. Whole15.dat - same as whole6.dat but with 2m channel widening option
6. Whole16.dat - same as whole6.dat but with 1.35m dia. pipe option
7. Whole17.dat - same as whole6.dat but with 3x2m box culvert option

4.5 Floodplain Modelling

Two areas, above and below Parklands Road were modelled as storages with reservoir units. The floodplain downstream was modelled by extending the channel cross-sections. Many areas were modelled as dead storage because garden walls and fences ran perpendicular to the direction of flow. All structures were modelled with Bernoulli Loss and Spill units and the losses assessed in detail.

4.6 Honey Brook

The assessment of the Honey Brook channel capacity was made with a separate model.

5. CALIBRATION

No calibration data was available for in-bank fitting. Rainfall data in the area and flow data at the flume were checked to see if steady conditions occurred at the time of the channel survey. Varying flows during the survey, however, meant that the surveyed w/l information could not be used for calibration purposes.

Water level recorders were requested and installed early on in the study and hopefully useful proving data will be forthcoming in the near future to confirm the results.

5.1 Justification of Manning's n

There is no in-bank calibration data at present. The reasons for the choice of Manning's n used in this study are set out below.

Ven te chow (Ref: open-channel hydraulics)

Using photographs in Fig 5-5 (pp 115-123)

Natural channel	n = 0.04+

Using Table 5-6 (pp 110-113)

Formed concrete	0.02

Using Cowan's procedure and Table 5-5 (p109)

Natural channel	n0 = 0.02
	n1 = 0.01
	n2 = 0.005
	n3 = 0.00
	n4 = 0.01
	n5 = 1.00
	n = 0.045

Site Visits

The natural channel is generally a smooth, earth channel near the bed, n = 0.03. Dense vegetation, mostly trees and bushes, towards the top of the banks will dramatically increase the roughness at high flows, n = 0.07 - 1.0.

The concrete lined channel along Broomstick Hall Rd (nodes 1037-1034) has very pronounced roughness elements so n can be increased from 0.02

to 0.025.

The trapezoidal channel (nodes 1039-1038) is lined with concrete stabilizing blocks. Vegetation has grown through the joints n = 0.03.

Flood event calibration

To simulate the 29/7/87 recorded flood levels using the out-of-bank model, high, natural channel roughness of at least n = 0.05 was required.

Summary

Natural Channel

Chow gives n = 0.045. Site visits suggest n = 0.05 is probably a good lumped estimate (although in reality roughness is clearly non-uniformly distributed). Of most significance was the flood event proving which demonstrated that a roughness of less than 0.05 would not allow an acceptable fit between recorded and simulated flood levels. For the in-bank model natural channel roughness was set at n = 0.05.

Concrete Lined Channel

Chow gives n = 0.02. Where one side of a channel reach is natural and the other concrete lined, two values of roughness (n = 0.05 & 0.02) are used.

For rectangular channel (nodes 1037-1034) n = 0.025
For trapezoidal channel (nodes 1039-1038) n = 0.03

5.2 Accuracy of Results

As well as uncertainties associated with the flows input to the model there are uncertainties associated with the hydraulic model, especially in the estimation of channel roughness.

Sensitivity of levels to changes in flow over the range of flows were investigated - increase flow by 10% and water levels increase by about 0.15m.

6. FLUME RATING

6.1 Introduction

The Sewardstone Rd. structure is described in the station details as a "Trapezoidal throated flume with hump in bed". The hydrometric group have used a theoretical modular rating and assumed it correct to bank-full. At the start of the study, there were no grounds for suspecting drowning.

6.2 Development of Investigation

At the beginning an attempt was made to simulate the modular rating using the CONQH unit (a rating curve model). Even with the modular

limit set to 0.999 the unit generated a "drowned" non-modular rating at high in-bank flows (see graph).

The next step was to remove the structure from the model and examine the d/s levels in the natural channel. Model runs showed that for high in-bank flows the d/s levels were greater than the u/s levels given by the modular rating curve. This proved that the structure was in fact drowned out and had no influence on the flow. For high in-bank flows a drowned rating was generated by running the "no flume" model. (The point at which the modular rating and "no flume" curves intersect is where the d/s level/channel starts to control the flow rather than the flume).

6.3 Influence of Manning's n

A complicating factor is that levels d/s from the flume are controlled by the choice of Manning's n for the channel and there is a degree of uncertainty as to the correct value to use (because model currently uncalibrated). For a particular flow channel roughness was varied within a realistic range. The drowning curves for the different assumptions of Manning's n showed how non-modularity increased with increasing n. With the information currently available it is felt that n = 0.04 for this particular reach is appropriate.

6.4 Observation of Drowned Flow

Further evidence of drowning came from Rod Hawnt (Hydrologic Ltd) in a chance meeting after the study was completed. He has long suspected drowning and can remember seeing a flat flow profile across the flume well before bank-full flow.

6.5 Reduction in flows

The implication of the study is that high in-bank flows need to be corrected downwards as shown below.

H(m)	Q (cumecs) (from modular rating)	Correction (cumecs)
0	No Change	0
1.2	No Change	0
1.3	13.8	-1
1.4	16.7	-2
1.5	19.9	-4
1.6	23.2	-5

6.6 Future work

The precise nature of the drowning needs to be confirmed in the field by installing a w/l recorder just d/s of the flume.

7. RESULTS

Results of the model study are presented in Tables 1, 2 and 3.
Freeboard has not been considered.
The results output by ONDA are given in Appendix B.

TABLE 1

CHANNEL CAPACITY
(Cumecs)

%age of total flow through pipe shown in brackets

	REACH	
	Trapezoidal channel (nodes 1039 - 1038)	Rectangular channel (nodes 1037 - 1034)
Existing	13 bankfull 26 DPC level	17
Existing with 1.35m dia. pipe	14 (14%)	18 (12%)
Existing with 3 x 2m box culvert	19 (52%)	21 (49%)
Existing with channel widened by 1m	18	22
Existing with channel widened by 2m	22	26
Existing with bed lowered d/s by 0.5m	13	18

TABLE 2

AMOUNT BANK HEIGHTS NEED TO BE RAISED TO CONTAIN FLOW
(Metres)

	Existing			
	25.8m3/s T=30yrs	28.9m3/s T=50yrs	34.1m3/s T=100yrs	26.9m3/s T=50yrs*
L.B. u/s from Paternoster Hill nursery (site not visited) (nodes 1048-1047)	0.4	0.6	0.9	0.45
L.B. u/s from Parklands Rd along Galleyhill Rd (nodes 1044-1042)	0.2	0.8	1.4	0.4
Parklands Rd down to Broomstick Hall Rd bridge (nodes 1041-1040)	0.1	0.7	1.2	0.2
u/s Honey/Cobbins confluence down to Honey Lane (nodes 50-1034)	0.8-1.1	1.1-1.4	1.5-1.9	0.9-1.3
R.B. Honey Lane Rd bridge down to channel opposite Rounton Rd (nodes 1034-1031)	0.1	0.3	0.5	0.2

* with u/s storage about 2 cumecs can be taken off the 50 year return period flow, reducing the peak from 28.9 to 26.9 cumecs.

.../continued

	1.35m dia. pipe				3x2m box culvert			
	25.8 T=30	28.9 T=50	34.1 T=100	26.9 T= 50*	25.8 T=30	28.9 T=50	34.1 T=100	26.9 T=50*
nodes 1048-1047	0.4	0.5	0.8	0.45	0.4	0.5	0.8	0.45
nodes 1044-1042	0.2	0.7	1.3	0.3	0.2	0.5	1.3	0.3
nodes 1041-1040	-	0.5	1.2	0.2	-	0.3	1.1	0.1
nodes 50-1034	0.7-1.0	1.0-1.3	1.4-1.7	0.8-1.1	0.5-0.6	0.7-0.9	1.0-1.2	0.5-0.7
nodes 1034-1031	0.1	0.3	0.5	0.2	0.1	0.3	0.5	0.2

	1m channel widening			2m channel widening		
	25.8 T=30	28.9 T=50	26.9 T=50*	25.8 T=30	28.9 T=50	26.9 T=50*
nodes 1048-1047	0.3	0.4	0.3	0.1	0.2	0.2
nodes 1044-1042	-	-	-	-	-	-
nodes 1041-1040	-	-	-	-	-	-
nodes 50-1034	0.3-0.7	0.6-1.0	0.4-0.8	0.2-0.4	0.2-0.6	0.1-0.5
nodes 1034-1031	-	-	-	-	-	-

	lowered bed d/s		
	25.8 T=30	28.9 T=50	26.9 T=50*
nodes 1048-1047	0.4	0.6	0.5
nodes 1044-1042	0.2	0.8	0.3
nodes 1041-1040	0.1	0.7	0.2
nodes 50-1034	0.6- 1.0	1.0- 1.4	0.7- 1.1
nodes 1034-1031	-	0.2	-

TABLE 3

MAXIMUM DISCHARGES AT STRUCTURES

The maximum discharge condition is reached when the flow just u/s of the structure/obstruction is bank full.

Structure (node)	Maximum Discharge (Cumecs)
Parklands Rd bridge (1042)	26
Broomstick Hall Rd bridge (1040)	26
Pipe crossing x2 just d/s from Broomstick Hall Rd bridge	28
Footbridge access to Eastbrook Hall	17
Footbridge access to houses No.s 2,4, & 6	17
Honey Lane bridge (1034)	24
Pipe crossing opposite Rounton Rd	34
Footbridge access from Honey Lane to Larsen Rec.	33
Pipe crossing d/s from footbridge above	33
Footbridge u/s from Rochford Avenue (12)	> 40
Rochford Avenue Rd bridge (10)	> 40
Footbridge u/s from flume	16 *
Flume	19 *
Pipe crossing d/s from flume	29 *
M25 culvert (1022)	> 40
Pipe crossing x2 d/s from M25 culvert	> 40

* out of bank flows up to 40 cumecs are not a problem here.

8. CONCLUSIONS

The in-bank ONDA model is uncalibrated. It was constructed using all available data and information gained from site visits and consultations with project staff. However w/l recorders have been installed and hopefully, in the near future, useful proving data will be forthcoming which will confirm the results and conclusions.

The numbered points below correspond to those in the terms of reference.

1. Some of the 23 measured flood levels showed a large variation across the width of the envelope and a couple of levels were assumed to be outliers.

   In order to simulate the flood envelope high channel roughness and a peak flow of 40 cumecs were necessary.

2. Channel capacity varies greatly along the 3Km length of Cobbins Brook modelled from 13 to over 40 cumecs.

   The area where river flow first comes out-of-bank causing concern due to flooding of gardens and roads is from u/s Honey/Cobbins confluence down to Honey Lane (nodes 46-1034).

   The capacity of the trapezoidal channel (nodes 1039-1038) is 13 cumecs. A detailed survey carried out further away from the channel showed that if higher secondary "bank-full" levels at the d.p.c. level of houses are used then 26 cumecs can be conveyed.

   The capacity of the rectangular channel alongside Broomstick Hall Rd. u/s of Honey Lane (nodes 1037-1034) is 17 cumecs.

3.a) The flume was shown to drown at high in-bank flows. It does not therefore cause afflux and its removal would not increase the conveyance of the channel. Low bank-full levels u/s from the flume explain the 29/7/87 event local flood envelope.

b) At channel capacity flows (either 13 or 17 cumecs - see conclusion No.2) the backwater caused by pipe crossings are small, 0 - 0.04m and are not in the critical area. The backwaters caused by the two footbridges on Broomstick Hall Rd. are small, 0.015 - 0.04m and their effect on channel capacity negligible.

4.a) To contain the 30 year return period flow of 25.8 cumecs bank heights need to be raised by about 0.8 - 1.1m in the area u/s from Honey/Cobbins confluence down to Honey Lane (nodes 46-1034) and by lesser amounts at other locations as shown in Table 2.

b) To contain 28.9 cumecs (T = 50 years) bank heights need to be raised by about 1.1 - 1.4m.

c) To contain 34.1 cumecs (T = 100 years) bank heights need to be raised by about 1.5 - 1.9m.

d) To contain 26.9 cumecs (T = 50ST years) bank heights need to be raised by about 0.9 - 1.3m.

5. The maximum discharges of the road bridges were found to be:-

Parklands	26 cumecs
Broomstick Hall	26
Honey Lane	24
Rochford Avenue	> 40

The limiting maximum flow condition is 24 cumecs at Honey Lane road bridge.

6.a) i) With a 1.35m dia. by-pass pipe running down Eastbrook Rd. the total capacity (channel + pipe flow) is increased by 1 cumec to 14 cumecs in the trapezoidal channel (nodes 1039-1038) and to 18 cumecs in the rectangular channel (nodes 1037-1034).

ii) With a 3 x 2m box culvert the total capacity is increased by 6 cumecs to 19 cumecs between nodes 1039-1038 and by 4 cumecs to 21 cumecs between nodes 1037-1034.

b) <u>1.35 dia. pipe option</u>

i) To contain the 30 year return period flow of 25.8 cumecs bank heights need to be raised by about 0.7 - 1.0m in the area u/s from Honey/Cobbins confluence down to Honey Lane (nodes 50-1034) and by lesser amounts at other locations as shown in Table 2.

ii) To contain 28.9 cumecs (T = 50 years) bank heights need to be raised by about 1.0 - 1.3m.

iii) To contain 34.1 cumecs (T = 100 years) bank heights need to be raised by about 1.4 - 1.7m.

iv) To contain 26.9 cumecs (T = 50ST years) bank heights need to be raised by about 0.8 - 1.1m.

<u>3 x 2m culvert option</u>

i) To contain the 30 year return period flow of 25.8 cumecs bank heights need to be raised by about 0.5 - 0.6m in the area u/s from Honey/Cobbins confluence down to Honey Lane (nodes 50-1034) and by lesser amounts at other locations as shown in Table 2.

ii) To contain 28.9 cumecs (T = 50 years) bank heights need to be raised by about 0.7 - 0.9m.

iii) To contain 34.1 cumecs (T = 100 years) bank heights need to be raised by about 1.0 - 1.2m.

iv) To contain 26.9 cumecs (T = 50ST years) bank heights need to be raised by about 0.5 - 0.7m.

7. Channel capacity in Honey Brook is well above 4.1 cumecs (4.1 cumecs is the Honey brook component of the 34.1 cumec T = 100 years flow).

The out-of-bank flooding from the confluence to just u/s from Rounton Road (see 29/7/87 event flood envelope) is generated by the Cobbins brook flow.

8.a) i) With the channel widened by 1m between u/s Paternoster Hill (nodes 1048-3) and the flume, the capacity is increased by 5 cumecs to 18 cumecs in the trapezoidal channel (nodes 1039-1038) and to 22 cumecs in the rectangular channel (nodes 1037-1034).

ii) With the channel widened by 2m between u/s Paternoster Hill (nodes 1048-3) and the flume, the capacity is increased by 9 cumecs to 22 cumecs in the trapezoidal channel (nodes 1039-1038) and to 26 cumecs in the rectangular channel (nodes 1037-1034).

b) 1m Widening

i) To contain the 30 year return period flow of 25.8 cumecs bank heights need to be raised by about 0.3 - 0.7m in the area u/s from Honey/Cobbins confluence down to Honey Lane (nodes 50-1034) and by lesser amounts at other locations as shown in Table 2.

ii) To contain 28.9 cumecs (T = 50 years) bank heights need to be raised by about 0.6 - 1.0m.

iii) To contain 26.9 cumecs (storage T = 50ST years) bank heights need to be raised by about 0.4 - 0.8m.

2m Widening

i) To contain the 30 year return period flow of 25.8 cumecs bank heights need to be raised by about 0.2 -0.4m in the area u/s from Honey/Cobbins confluence down to Honey Lane (nodes 50-1034) and by lesser amounts at other locations as shown in Table 2.

ii) To contain 28.9 cumecs (T = 50 years) bank heights need to be raised by about 0.2 - 0.6m.

iii) To contain 26.9 cumecs (T = 50ST years) bank heights need to be raised by about 0.1 - 0.5m.

9.a) With the channel bed dredged/lowered by 0.5m between the middle of Larsen Rec. down to the flume (nodes 18-3) the capacity of the channel is increased by 1 cumec to 18 cumecs in the rectangular channel (nodes 1037-1034).

b) i) To contain the 30 year return period flow of 25.8 cumecs bank heights need to be raised by about 0.6 - 1.0m in the area u/s from Honey/Cobbins confluence down to Honey Lane

(nodes 50-1034) and by lesser amounts at other locations as shown in Table 2.

ii) To contain 28.9 cumecs (T = 50 years) bank heights need to be raised by about 1.0 - 1.4m.

iii) To contain 26.9 cumecs (T = 50ST years) bank heights need to be raised by about 0.7 - 1.1m.

9. GLOSSARY OF TERMS

backwater of a structure/obstruction = increase in w/l just u/s compared with if it was not there.

channel capacity = maximum in-bank flow

d/s = downstream

L.B. = left bank

maximum discharge of a structure = discharge for which flow u/s is bank-full.

R.B. = right bank

u/s = upstream

w/l = water level

50ST = 50 year return period with u/s storage

APPENDIX A

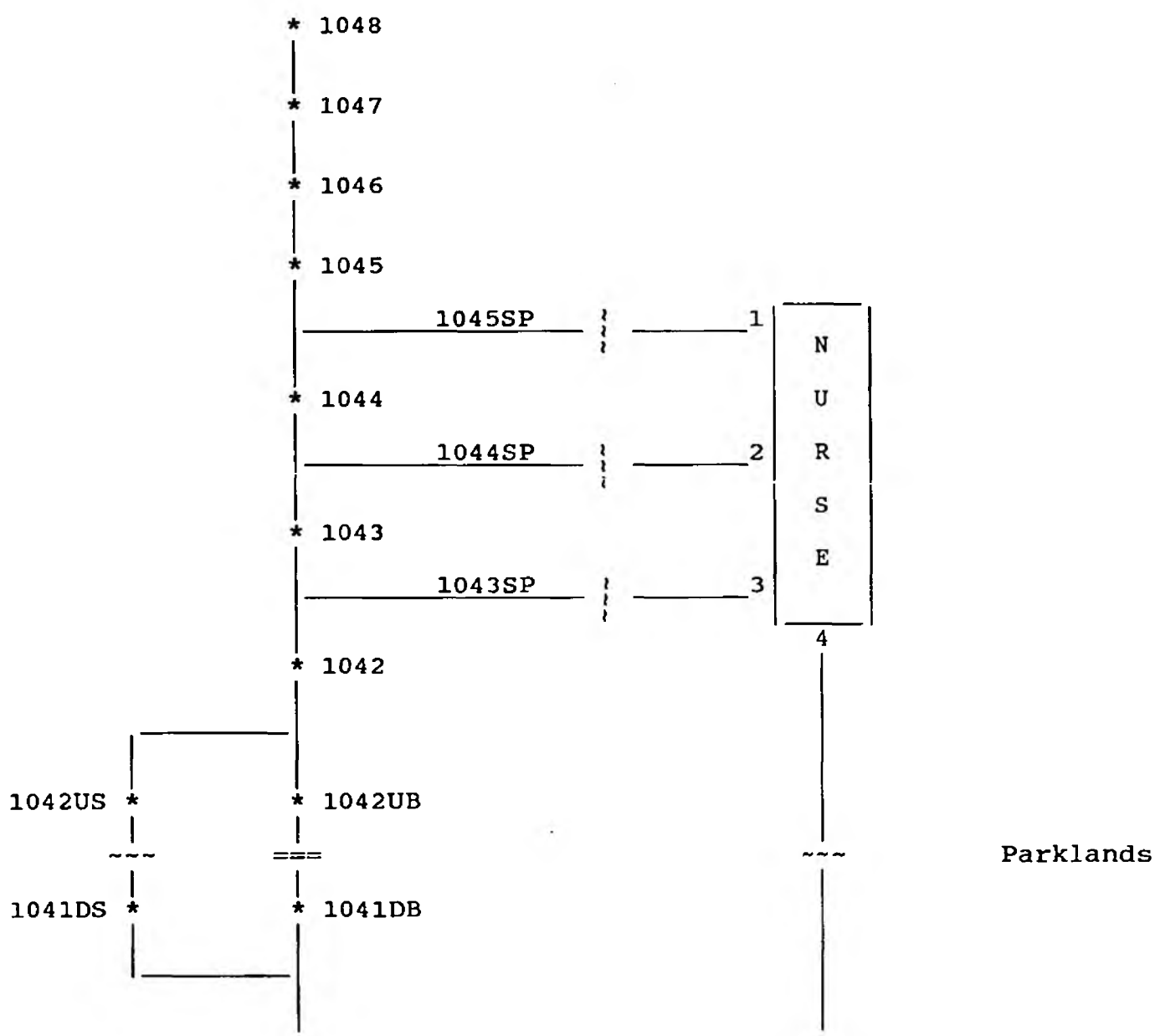
COBBINS BROOK ONDA MODEL
Node connectivity diagram for out-of-bank model

KEY

=== Bernoulli loss (either entrance, exit or lumped)

~~~ Spill

| | Reservoir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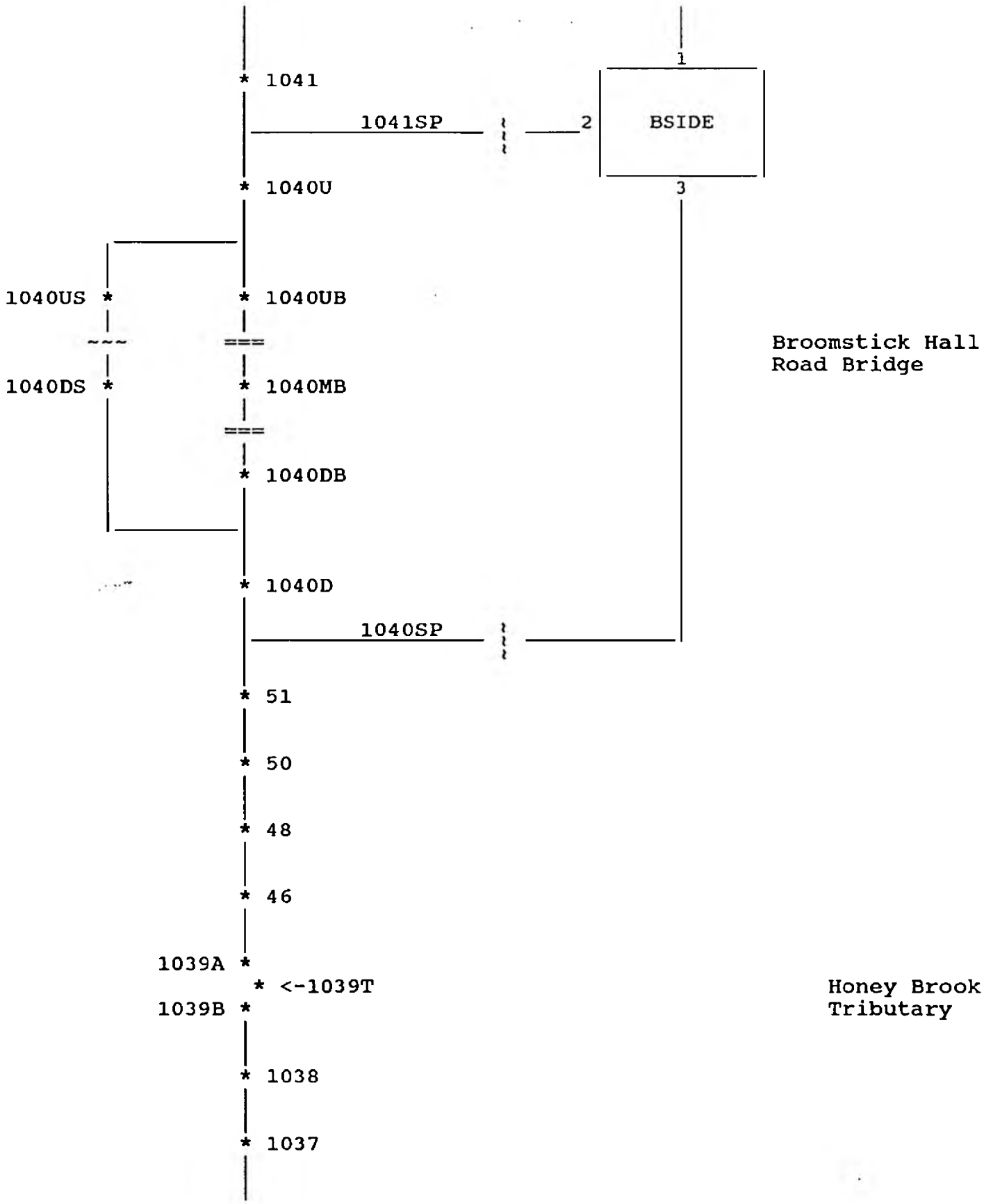
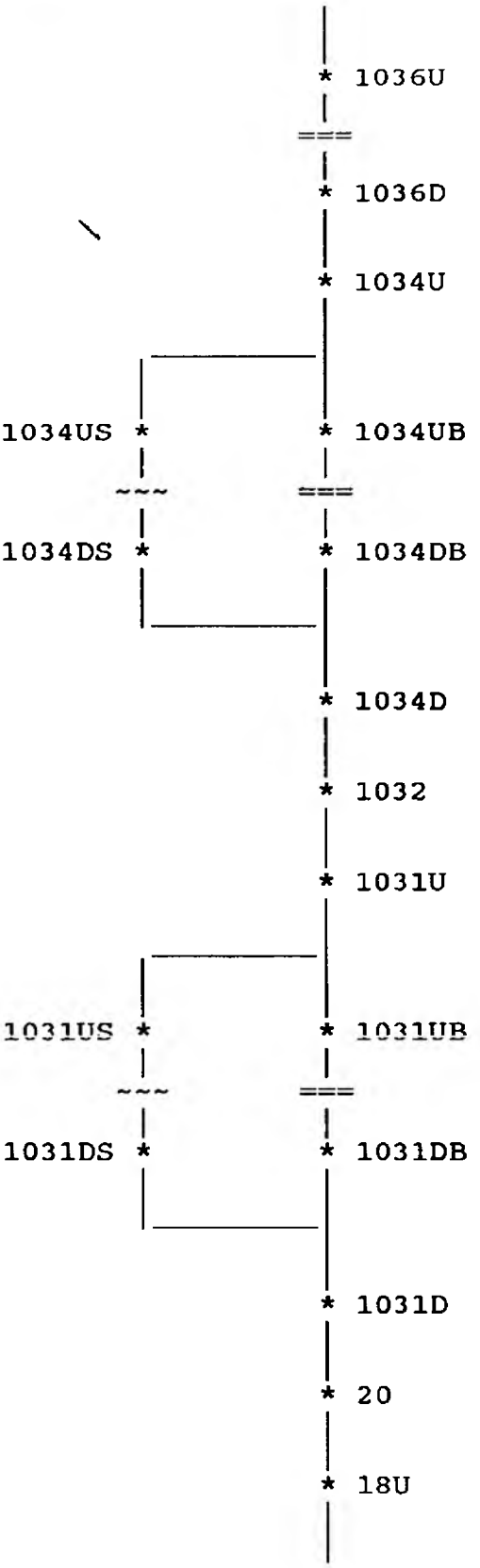
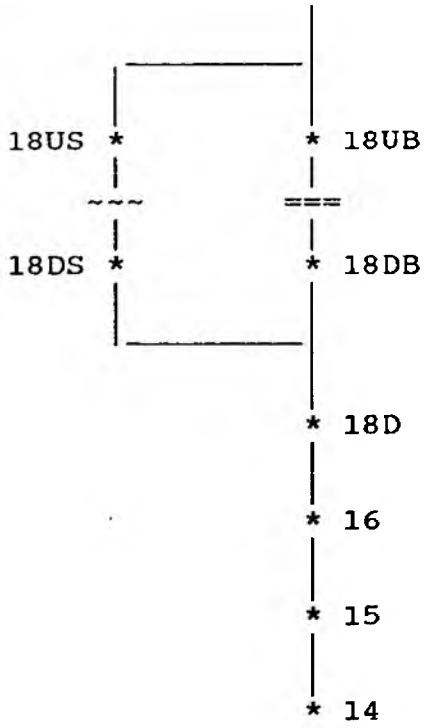

1
* 1041
1041SP
2
BSIDE
* 1040U
3
1040US *
* 1040UB
~~~
===
Broomstick Hall
Road Bridge
1040DS *
* 1040MB
===
* 1040DB
* 1040D
1040SP
* 51
* 50
* 48
* 46
1039A *
* <-1039T
Honey Brook
Tributary
1039B *
* 1038
* 1037
~~~



Footbridge to Cottages 2,4 & 6

Honey Lane Road Bridge

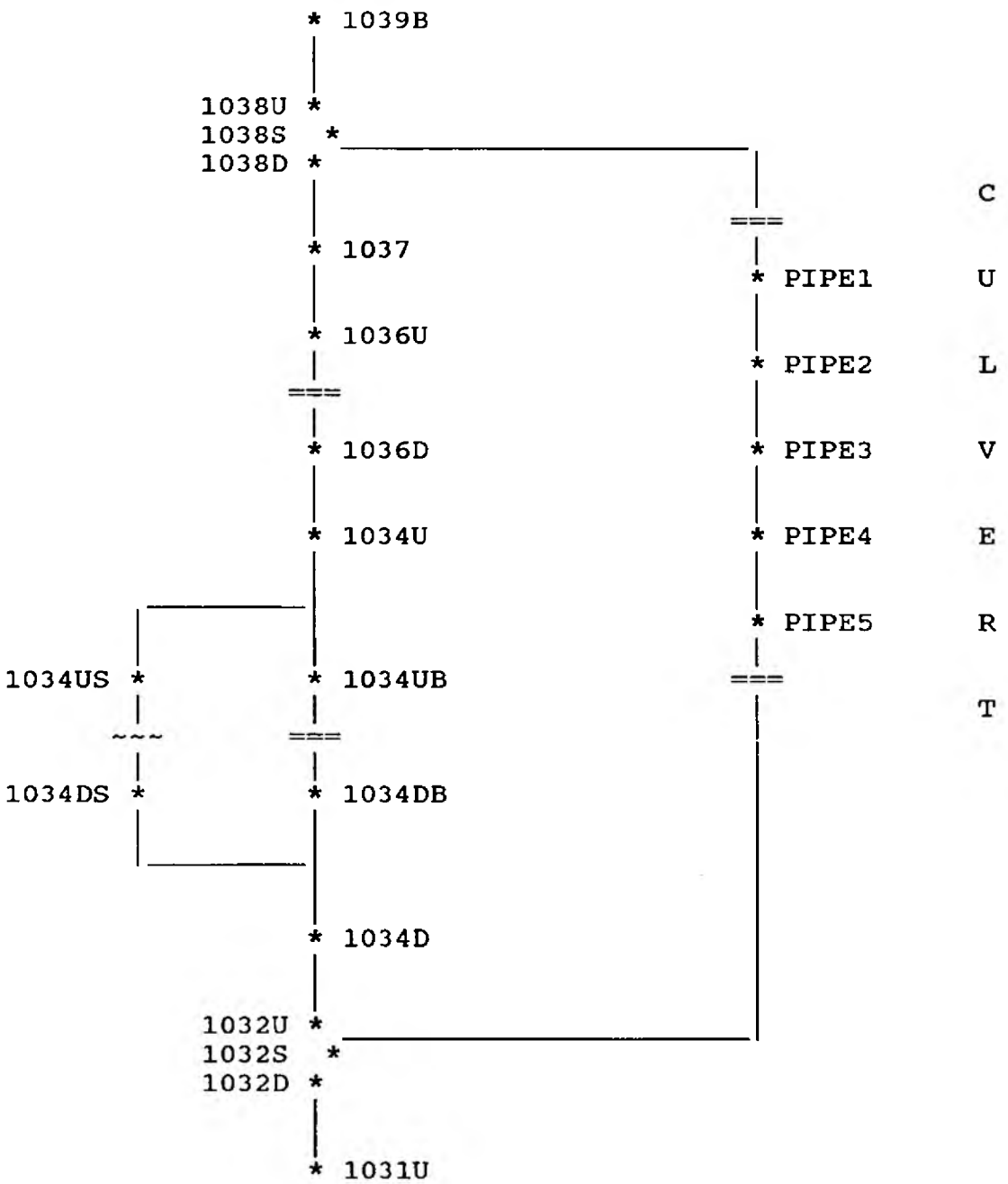
Pipe Crossing



Pipe Crossing

Node connectivity for in-bank model

The in-bank model is the same as the out-of-bank model without the out-of-bank units i.e. the reservoirs and spills. The by-pass pipe option node connectivity between nodes 1039B and 1031U is shown below.



APPENDIX B

Existing
13 cumecs

label	flow	stage
1048	11.400	24.497
1047	11.400	24.159
1046	11.400	23.825
1045	11.400	23.416
1044	11.400	22.949
1043	11.400	22.695
1042	11.400	22.574
1041	11.400	22.570
1040U	11.400	22.287
1040M	11.400	22.277
1040D	11.400	22.253
51	11.400	22.115
50	11.400	21.953
48	11.400	21.781
46	11.400	21.607
1039A	11.400	21.278
1039T	1.600	21.278
1039B	13.000	21.278
1038	13.000	21.236
1037	13.000	20.889
1036U	13.000	20.684
1036D	13.000	20.684
1034U	13.000	20.569
1034D	13.000	20.569
1032	13.000	20.451
1031U	13.000	20.309
1031D	13.000	20.309
20	13.000	20.214
18U	13.000	20.107
18D	13.000	20.107
16	13.000	19.937
15	13.000	19.708
12U	13.000	19.488
11	13.000	19.488
10D	13.000	19.488
7	13.000	19.259
6	13.000	19.120
5	13.000	18.986
4	13.000	18.822
3	13.000	18.699
1030	13.000	18.610
1027U	13.000	18.534
1027D	13.000	18.507
1026	13.000	18.425
1025	13.000	18.295
1024	13.000	18.194
1023	13.000	17.965
1022	13.000	17.897
1021	13.000	17.673
1020	13.000	17.652
1019	13.000	17.283
1018	13.000	17.231
1017U	13.000	17.155
1017D	13.000	17.155
1016	13.000	17.145
1015	13.000	17.079
1014	13.000	17.069
1013	13.000	17.030
1012	13.000	16.995
1010	13.000	16.946
1009	13.000	16.933

1008	13.000	16.913
1007	13.000	16.884
1006	13.000	16.839
1005	13.000	16.800
1003	13.000	16.766
1002	13.000	16.754
1001	13.000	16.760

Existing
17 cumecs

label	flow	stage
1048	15.000	24.743
1047	15.000	24.370
1046	15.000	24.064
1045	15.000	23.696
1044	15.000	23.265
1043	15.000	23.044
1042	15.000	22.940
1041	15.000	22.928
1040U	15.000	22.575
1040M	15.000	22.550
1040D	15.000	22.523
51	15.000	22.356
50	15.000	22.184
48	15.000	22.053
46	15.000	21.926
1039A	15.000	21.654
1039T	2.000	21.654
1039B	17.000	21.654
1038	17.000	21.618
1037	17.000	21.302
1036U	17.000	21.072
1036D	17.000	21.057
1034U	17.000	20.922
1034D	17.000	20.912
1032	17.000	20.747
1031U	17.000	20.577
1031D	17.000	20.577
20	17.000	20.458
18U	17.000	20.372
18D	17.000	20.372
16	17.000	20.222
15	17.000	20.013
12U	17.000	19.780
11	17.000	19.778
10D	17.000	19.778
7	17.000	19.546
6	17.000	19.398
5	17.000	19.256
4	17.000	19.086
3	17.000	18.968
1030	17.000	18.884
1027U	17.000	18.788
1027D	17.000	18.741
1026	17.000	18.651
1025	17.000	18.511
1024	17.000	18.409
1023	17.000	18.189
1022	17.000	18.104
1021	17.000	17.854
1020	17.000	17.837
1019	17.000	17.418
1018	17.000	17.386
1017U	17.000	17.293
1017D	17.000	17.293
1016	17.000	17.289
1015	17.000	17.209
1014	17.000	17.207
1013	17.000	17.161
1012	17.000	17.116
1010	17.000	17.048
1009	17.000	17.031

1008	17.000	17.005
1007	17.000	16.964
1006	17.000	16.894
1005	17.000	16.831
1003	17.000	16.772
1002	17.000	16.750
1001	17.000	16.760

Existing
25.8 cumecs

label	flow	stage
1048	22.800	25.056
1047	22.800	24.742
1046	22.800	24.508
1045	22.800	24.213
1044	22.800	23.942
1043	22.800	23.852
1042	22.800	23.791
1041	22.800	23.697
1040U	22.800	23.255
1040M	22.800	23.132
1040D	22.800	23.066
51	22.800	22.879
50	22.800	22.722
48	22.800	22.655
46	22.800	22.579
1039A	22.800	22.341
1039T	3.000	22.341
1039B	25.800	22.341
1038	25.800	22.301
1037	25.800	22.130
1036U	25.800	21.996
1036D	25.800	21.856
1034U	25.800	21.850
1034D	25.800	21.524
1032	25.800	21.384
1031U	25.800	21.108
1031D	25.800	21.067
20	25.800	20.923
18U	25.800	20.872
18D	25.800	20.869
16	25.800	20.750
15	25.800	20.584
12U	25.800	20.316
11	25.800	20.305
10D	25.800	20.305
7	25.800	20.077
6	25.800	19.923
5	25.800	19.752
4	25.800	19.572
3	25.800	19.422
1030	25.800	19.332
1027U	25.800	19.219
1027D	25.800	19.189
1026	25.800	19.090
1025	25.800	18.938
1024	25.800	18.834
1023	25.800	18.626
1022	25.800	18.498
1021	25.800	18.207
1020	25.800	18.205
1019	25.800	17.694
1018	25.800	17.691
1017U	25.800	17.573
1017D	25.800	17.573
1016	25.800	17.591
1015	25.800	17.490
1014	25.800	17.508
1013	25.800	17.455
1012	25.800	17.392
1010	25.800	17.286
1009	25.800	17.270

1008	25.800	17.235
1007	25.800	17.177
1006	25.800	17.061
1005	25.800	16.942
1003	25.800	16.798
1002	25.800	16.736
1001	25.800	16.760

Existing
26 cumecs

label	flow	stage
1048	22.900	25.060
1047	22.900	24.748
1046	22.900	24.514
1045	22.900	24.221
1044	22.900	23.954
1043	22.900	23.865
1042	22.900	23.806
1041	22.900	23.709
1040U	22.900	23.273
1040M	22.900	23.146
1040D	22.900	23.078
51	22.900	22.889
50	22.900	22.733
48	22.900	22.668
46	22.900	22.593
1039A	22.900	22.357
1039T	3.100	22.357
1039B	26.000	22.357
1038	26.000	22.318
1037	26.000	22.150
1036U	26.000	22.016
1036D	26.000	21.873
1034U	26.000	21.869
1034D	26.000	21.531
1032	26.000	21.394
1031U	26.000	21.119
1031D	26.000	21.077
20	26.000	20.933
18U	26.000	20.882
18D	26.000	20.879
16	26.000	20.760
15	26.000	20.594
12U	26.000	20.324
11	26.000	20.314
10D	26.000	20.314
7	26.000	20.085
6	26.000	19.931
5	26.000	19.760
4	26.000	19.580
3	26.000	19.431
1030	26.000	19.342
1027U	26.000	19.229
1027D	26.000	19.199
1026	26.000	19.100
1025	26.000	18.948
1024	26.000	18.843
1023	26.000	18.635
1022	26.000	18.506
1021	26.000	18.215
1020	26.000	18.212
1019	26.000	17.700
1018	26.000	17.698
1017U	26.000	17.579
1017D	26.000	17.579
1016	26.000	17.597
1015	26.000	17.496
1014	26.000	17.515
1013	26.000	17.462
1012	26.000	17.398
1010	26.000	17.292
1009	26.000	17.275

1008	26.000	17.241
1007	26.000	17.183
1006	26.000	17.066
1005	26.000	16.946
1003	26.000	16.799
1002	26.000	16.736
1001	26.000	16.760

Existing
26.9 cumecs

label	flow	stage
1048	23.700	25.093
1047	23.700	24.794
1046	23.700	24.572
1045	23.700	24.295
1044	23.700	24.058
1043	23.700	23.982
1042	23.700	23.932
1041	23.700	23.818
1040U	23.700	23.450
1040M	23.700	23.217
1040D	23.700	23.150
51	23.700	22.950
50	23.700	22.797
48	23.700	22.737
46	23.700	22.668
1039A	23.700	22.437
1039T	3.200	22.437
1039B	26.900	22.437
1038	26.900	22.398
1037	26.900	22.244
1036U	26.900	22.116
1036D	26.900	21.961
1034U	26.900	21.965
1034D	26.900	21.564
1032	26.900	21.442
1031U	26.900	21.171
1031D	26.900	21.119
20	26.900	20.977
18U	26.900	20.929
18D	26.900	20.923
16	26.900	20.805
15	26.900	20.640
12U	26.900	20.363
11	26.900	20.351
10D	26.900	20.351
7	26.900	20.119
6	26.900	19.967
5	26.900	19.794
4	26.900	19.613
3	26.900	19.470
1030	26.900	19.386
1027U	26.900	19.273
1027D	26.900	19.245
1026	26.900	19.145
1025	26.900	18.991
1024	26.900	18.884
1023	26.900	18.677
1022	26.900	18.543
1021	26.900	18.246
1020	26.900	18.246
1019	26.900	17.725
1018	26.900	17.728
1017U	26.900	17.607
1017D	26.900	17.607
1016	26.900	17.627
1015	26.900	17.524
1014	26.900	17.545
1013	26.900	17.492
1012	26.900	17.427
1010	26.900	17.317
1009	26.900	17.301

1008	26.900	17.266
1007	26.900	17.207
1006	26.900	17.086
1005	26.900	16.961
1003	26.900	16.803
1002	26.900	16.734
1001	26.900	16.760

Existing
28.9 cumecs

label	flow	stage
1048	25.500	25.197
1047	25.500	24.947
1046	25.500	24.787
1045	25.500	24.590
1044	25.500	24.447
1043	25.500	24.402
1042	25.500	24.376
1041	25.500	24.216
1040U	25.500	24.046
1040M	25.500	23.424
1040D	25.500	23.376
51	25.500	23.167
50	25.500	22.990
48	25.500	22.893
46	25.500	22.832
1039A	25.500	22.607
1039T	3.400	22.607
1039B	28.900	22.607
1038	28.900	22.569
1037	28.900	22.437
1036U	28.900	22.318
1036D	28.900	22.134
1034U	28.900	22.150
1034D	28.900	21.656
1032	28.900	21.570
1031U	28.900	21.309
1031D	28.900	21.213
20	28.900	21.076
18U	28.900	21.031
18D	28.900	21.018
16	28.900	20.904
15	28.900	20.741
12U	28.900	20.447
11	28.900	20.433
10D	28.900	20.433
7	28.900	20.194
6	28.900	20.045
5	28.900	19.869
4	28.900	19.686
3	28.900	19.552
1030	28.900	19.478
1027U	28.900	19.365
1027D	28.900	19.340
1026	28.900	19.239
1025	28.900	19.082
1024	28.900	18.969
1023	28.900	18.770
1022	28.900	18.624
1021	28.900	18.316
1020	28.900	18.320
1019	28.900	17.776
1018	28.900	17.790
1017U	28.900	17.663
1017D	28.900	17.663
1016	28.900	17.690
1015	28.900	17.584
1014	28.900	17.611
1013	28.900	17.557
1012	28.900	17.489
1010	28.900	17.373
1009	28.900	17.358

1008	28.900	17.322
1007	28.900	17.262
1006	28.900	17.133
1005	28.900	16.999
1003	28.900	16.815
1002	28.900	16.730
1001	28.900	16.760

Existing
34.1 cumecs

label	flow	stage
1048	30.000	25.488
1047	30.000	25.319
1046	30.000	25.222
1045	30.000	25.083
1044	30.000	24.996
1043	30.000	24.970
1042	30.000	24.953
1041	30.000	24.714
1040U	30.000	24.588
1040M	30.000	23.685
1040D	30.000	23.631
51	30.000	23.449
50	30.000	23.350
48	30.000	23.301
46	30.000	23.257
1039A	30.000	23.047
1039T	4.100	23.047
1039B	34.100	23.047
1038	34.100	23.009
1037	34.100	22.919
1036U	34.100	22.816
1036D	34.100	22.547
1034U	34.100	22.588
1034D	34.100	21.839
1032	34.100	21.800
1031U	34.100	21.549
1031D	34.100	21.502
20	34.100	21.355
18U	34.100	21.321
18D	34.100	21.293
16	34.100	21.176
15	34.100	21.023
12U	34.100	20.680
11	34.100	20.656
10D	34.100	20.648
7	34.100	20.391
6	34.100	20.246
5	34.100	20.071
4	34.100	19.872
3	34.100	19.739
1030	34.100	19.675
1027U	34.100	19.573
1027D	34.100	19.548
1026	34.100	19.444
1025	34.100	19.298
1024	34.100	19.188
1023	34.100	18.997
1022	34.100	18.821
1021	34.100	18.489
1020	34.100	18.506
1019	34.100	17.917
1018	34.100	17.966
1017U	34.100	17.826
1017D	34.100	17.804
1016	34.100	17.851
1015	34.100	17.741
1014	34.100	17.781
1013	34.100	17.725
1012	34.100	17.650
1010	34.100	17.522
1009	34.100	17.509

1008	34.100	17.471
1007	34.100	17.409
1006	34.100	17.264
1005	34.100	17.113
1003	34.100	16.859
1002	34.100	16.719
1001	34.100	16.760

Existing with 1.35m dia. pipe
14 cumecs

label	flow	stage
1048	12.300	24.560
1047	12.300	24.218
1046	12.300	23.895
1045	12.300	23.494
1044	12.300	23.028
1043	12.300	22.783
1042	12.300	22.668
1041	12.300	22.664
1040U	12.300	22.361
1040M	12.300	22.347
1040D	12.300	22.323
51	12.300	22.176
50	12.300	22.012
48	12.300	21.831
46	12.300	21.633
1039A	12.300	21.237
1039T	1.700	21.237
1039B	14.000	21.237
1038U	14.000	21.179
1038S	2.022	21.179
PIPE1	2.022	21.179
PIPE2	2.022	21.015
PIPE3	2.022	20.851
PIPE4	2.022	20.688
PIPE5	2.022	20.524
1038D	11.978	21.179
1037	11.978	20.868
1036U	11.978	20.701
1036D	11.978	20.701
1034U	11.978	20.610
1034D	11.978	20.610
1032U	11.978	20.524
1032S	2.022	20.524
1032D	14.000	20.524
1031U	14.000	20.375
1031D	14.000	20.375
20	14.000	20.273
18U	14.000	20.172
18D	14.000	20.172
16	14.000	20.009
15	14.000	19.788
12U	14.000	19.566
11	14.000	19.566
10D	14.000	19.566
7	14.000	19.333
6	14.000	19.192
5	14.000	19.056
4	14.000	18.891
3	14.000	18.769
1030	14.000	18.683
1027U	14.000	18.605
1027D	14.000	18.572
1026	14.000	18.487
1025	14.000	18.356
1024	14.000	18.254
1023	14.000	18.025
1022	14.000	17.953
1021	14.000	17.721
1020	14.000	17.700
1019	14.000	17.318
1018	14.000	17.271

1017U	14.000	17.191
1017D	14.000	17.191
1016	14.000	17.182
1015	14.000	17.112
1014	14.000	17.103
1013	14.000	17.062
1012	14.000	17.024
1010	14.000	16.971
1009	14.000	16.956
1008	14.000	16.935
1007	14.000	16.902
1006	14.000	16.851
1005	14.000	16.807
1003	14.000	16.767
1002	14.000	16.753
1001	14.000	16.760

Existing with 1.35m dia. pipe
18 cumecs

label	flow	stage
1048	15.900	24.780
1047	15.900	24.418
1046	15.900	24.118
1045	15.900	23.755
1044	15.900	23.335
1043	15.900	23.124
1042	15.900	23.023
1041	15.900	23.006
1040U	15.900	22.632
1040M	15.900	22.603
1040D	15.900	22.569
51	15.900	22.393
50	15.900	22.209
48	15.900	22.069
46	15.900	21.929
1039A	15.900	21.605
1039T	2.100	21.605
1039B	18.000	21.605
1038U	18.000	21.559
1038S	2.151	21.559
PIPE1	2.151	21.559
PIPE2	2.151	21.373
PIPE3	2.151	21.188
PIPE4	2.151	21.002
PIPE5	2.151	20.817
1038D	15.848	21.559
1037	15.848	21.268
1036U	15.848	21.072
1036D	15.848	21.059
1034U	15.848	20.953
1034D	15.848	20.941
1032U	15.848	20.817
1032S	2.151	20.817
1032D	18.000	20.817
1031U	18.000	20.644
1031D	18.000	20.644
20	18.000	20.517
18U	18.000	20.434
18D	18.000	20.434
16	18.000	20.290
15	18.000	20.084
12U	18.000	19.846
11	18.000	19.844
10D	18.000	19.844
7	18.000	19.610
6	18.000	19.459
5	18.000	19.313
4	18.000	19.138
3	18.000	19.019
1030	18.000	18.937
1027U	18.000	18.840
1027D	18.000	18.795
1026	18.000	18.704
1025	18.000	18.562
1024	18.000	18.459
1023	18.000	18.241
1022	18.000	18.151
1021	18.000	17.896
1020	18.000	17.882
1019	18.000	17.450
1018	18.000	17.422

1017U	18.000	17.326
1017D	18.000	17.326
1016	18.000	17.324
1015	18.000	17.242
1014	18.000	17.241
1013	18.000	17.194
1012	18.000	17.147
1010	18.000	17.075
1009	18.000	17.057
1008	18.000	17.029
1007	18.000	16.986
1006	18.000	16.910
1005	18.000	16.841
1003	18.000	16.773
1002	18.000	16.748
1001	18.000	16.760

Existing with 1.35m dia. pipe
25.8 cumecs

label	flow	stage
1048	22.800	25.055
1047	22.800	24.740
1046	22.800	24.504
1045	22.800	24.205
1044	22.800	23.927
1043	22.800	23.833
1042	22.800	23.770
1041	22.800	23.677
1040U	22.800	23.213
1040M	22.800	23.096
1040D	22.800	23.029
51	22.800	22.833
50	22.800	22.661
48	22.800	22.582
46	22.800	22.492
1039A	22.800	22.219
1039T	3.000	22.219
1039B	25.800	22.219
1038U	25.800	22.174
1038S	2.220	22.174
PIPE1	2.220	22.174
PIPE2	2.220	21.977
PIPE3	2.220	21.779
PIPE4	2.220	21.582
PIPE5	2.220	21.384
1038D	23.579	22.174
1037	23.579	21.997
1036U	23.579	21.865
1036D	23.579	21.754
1034U	23.579	21.738
1034D	23.579	21.501
1032U	23.579	21.384
1032S	2.220	21.384
1032D	25.800	21.384
1031U	25.800	21.108
1031D	25.800	21.067
20	25.800	20.923
18U	25.800	20.872
18D	25.800	20.869
16	25.800	20.750
15	25.800	20.584
12U	25.800	20.316
11	25.800	20.305
10D	25.800	20.305
7	25.800	20.077
6	25.800	19.923
5	25.800	19.752
4	25.800	19.572
3	25.800	19.422
1030	25.800	19.332
1027U	25.800	19.219
1027D	25.800	19.189
1026	25.800	19.090
1025	25.800	18.938
1024	25.800	18.834
1023	25.800	18.626
1022	25.800	18.498
1021	25.800	18.207
1020	25.800	18.205
1019	25.800	17.694
1018	25.800	17.691

1017U	25.800	17.573
1017D	25.800	17.573
1016	25.800	17.591
1015	25.800	17.490
1014	25.800	17.508
1013	25.800	17.455
1012	25.800	17.392
1010	25.800	17.286
1009	25.800	17.270
1008	25.800	17.235
1007	25.800	17.177
1006	25.800	17.061
1005	25.800	16.942
1003	25.800	16.798
1002	25.800	16.736
1001	25.800	16.760

Existing with 1.35m dia. pipe
26.9 cumecs

label	flow	stage
1048	23.700	25.091
1047	23.700	24.787
1046	23.700	24.561
1045	23.700	24.274
1044	23.700	24.023
1043	23.700	23.941
1042	23.700	23.886
1041	23.700	23.776
1040U	23.700	23.353
1040M	23.700	23.173
1040D	23.700	23.093
51	23.700	22.895
50	23.700	22.727
48	23.700	22.655
46	23.700	22.571
1039A	23.700	22.305
1039T	3.200	22.305
1039B	26.900	22.305
1038U	26.900	22.259
1038S	2.257	22.259
PIPE1	2.257	22.259
PIPE2	2.257	22.055
PIPE3	2.257	21.851
PIPE4	2.257	21.647
PIPE5	2.257	21.443
1038D	24.642	22.259
1037	24.643	22.094
1036U	24.643	21.968
1036D	24.643	21.844
1034U	24.643	21.837
1034D	24.643	21.545
1032U	24.643	21.442
1032S	2.257	21.442
1032D	26.900	21.442
1031U	26.900	21.171
1031D	26.900	21.119
20	26.900	20.977
18U	26.900	20.929
18D	26.900	20.923
16	26.900	20.805
15	26.900	20.640
12U	26.900	20.363
11	26.900	20.351
10D	26.900	20.351
7	26.900	20.119
6	26.900	19.967
5	26.900	19.794
4	26.900	19.613
3	26.900	19.470
1030	26.900	19.386
1027U	26.900	19.273
1027D	26.900	19.245
1026	26.900	19.145
1025	26.900	18.991
1024	26.900	18.884
1023	26.900	18.677
1022	26.900	18.543
1021	26.900	18.246
1020	26.900	18.246
1019	26.900	17.725
1018	26.900	17.728

1017U	26.900	17.607
1017D	26.900	17.607
1016	26.900	17.627
1015	26.900	17.524
1014	26.900	17.545
1013	26.900	17.492
1012	26.900	17.427
1010	26.900	17.317
1009	26.900	17.301
1008	26.900	17.266
1007	26.900	17.207
1006	26.900	17.086
1005	26.900	16.961
1003	26.900	16.803
1002	26.900	16.734
1001	26.900	16.760

Existing with 1.35m dia. pipe
28.9 cumecs

label	flow	stage
1048	25.500	25.173
1047	25.500	24.900
1046	25.500	24.716
1045	25.500	24.484
1044	25.500	24.306
1043	25.500	24.250
1042	25.500	24.216
1041	25.500	24.060
1040U	25.500	23.831
1040M	25.500	23.319
1040D	25.500	23.252
51	25.500	23.032
50	25.500	22.868
48	25.500	22.810
46	25.500	22.739
1039A	25.500	22.486
1039T	3.400	22.486
1039B	28.900	22.486
1038U	28.900	22.442
1038S	2.333	22.442
PIPE1	2.333	22.442
PIPE2	2.333	22.224
PIPE3	2.333	22.006
PIPE4	2.333	21.788
PIPE5	2.333	21.570
1038D	26.567	22.442
1037	26.567	22.306
1036U	26.567	22.192
1036D	26.567	22.042
1034U	26.567	22.052
1034D	26.567	21.642
1032U	26.567	21.570
1032S	2.333	21.570
1032D	28.900	21.570
1031U	28.900	21.309
1031D	28.900	21.213
20	28.900	21.076
18U	28.900	21.031
18D	28.900	21.018
16	28.900	20.904
15	28.900	20.741
12U	28.900	20.447
11	28.900	20.433
10D	28.900	20.433
7	28.900	20.194
6	28.900	20.045
5	28.900	19.869
4	28.900	19.686
3	28.900	19.552
1030	28.900	19.478
1027U	28.900	19.365
1027D	28.900	19.340
1026	28.900	19.239
1025	28.900	19.082
1024	28.900	18.969
1023	28.900	18.770
1022	28.900	18.624
1021	28.900	18.316
1020	28.900	18.320
1019	28.900	17.776
1018	28.900	17.790

1017U	28.900	17.663
1017D	28.900	17.663
1016	28.900	17.690
1015	28.900	17.584
1014	28.900	17.611
1013	28.900	17.557
1012	28.900	17.489
1010	28.900	17.373
1009	28.900	17.358
1008	28.900	17.322
1007	28.900	17.262
1006	28.900	17.133
1005	28.900	16.999
1003	28.900	16.815
1002	28.900	16.730
1001	28.900	16.760

Existing with 1.35m dia. pipe
34.1 cumecs

label	flow	stage
1048	30.000	25.470
1047	30.000	25.294
1046	30.000	25.191
1045	30.000	25.045
1044	30.000	24.952
1043	30.000	24.924
1042	30.000	24.907
1041	30.000	24.669
1040U	30.000	24.536
1040M	30.000	23.637
1040D	30.000	23.582
51	30.000	23.374
50	30.000	23.248
48	30.000	23.185
46	30.000	23.132
1039A	30.000	22.893
1039T	4.100	22.893
1039B	34.100	22.893
1038U	34.100	22.850
1038S	2.559	22.850
PIPE1	2.559	22.849
PIPE2	2.559	22.587
PIPE3	2.559	22.325
PIPE4	2.559	22.062
PIPE5	2.559	21.800
1038D	31.541	22.850
1037	31.541	22.751
1036U	31.541	22.649
1036D	31.541	22.426
1034U	31.541	22.458
1034D	31.541	21.833
1032U	31.541	21.800
10326	2.559	21.800
1032D	34.100	21.800
1031U	34.100	21.549
1031D	34.100	21.502
20	34.100	21.355
18U	34.100	21.321
18D	34.100	21.293
16	34.100	21.176
15	34.100	21.023
12U	34.100	20.680
11	34.100	20.656
10D	34.100	20.648
7	34.100	20.391
6	34.100	20.246
5	34.100	20.071
4	34.100	19.872
3	34.100	19.739
1030	34.100	19.675
1027U	34.100	19.573
1027D	34.100	19.548
1026	34.100	19.444
1025	34.100	19.298
1024	34.100	19.188
1023	34.100	18.997
1022	34.100	18.821
1021	34.100	18.489
1020	34.100	18.506
1019	34.100	17.917
1018	34.100	17.966

1017U	34.100	17.826
1017D	34.100	17.804
1016	34.100	17.851
1015	34.100	17.741
1014	34.100	17.781
1013	34.100	17.725
1012	34.100	17.650
1010	34.100	17.522
1009	34.100	17.509
1008	34.100	17.471
1007	34.100	17.409
1006	34.100	17.264
1005	34.100	17.113
1003	34.100	16.859
1002	34.100	16.719
1001	34.100	16.760

Existing with 3 x 2m box culvert
19 cumecs

label	flow	stage
1048	16.700	24.811
1047	16.700	24.454
1046	16.700	24.161
1045	16.700	23.801
1044	16.700	23.385
1043	16.700	23.186
1042	16.700	23.091
1041	16.700	23.069
1040U	16.700	22.674
1040M	16.700	22.640
1040D	16.700	22.601
51	16.700	22.414
50	16.700	22.212
48	16.700	22.051
46	16.700	21.876
1039A	16.700	21.320
1039T	2.300	21.320
1039B	19.000	21.320
1038U	19.000	21.178
1038S	9.938	21.178
PIPE1	9.938	21.175
PIPE2	9.938	21.130
PIPE3	9.938	21.050
PIPE4	9.938	20.970
PIPE5	9.938	20.890
1038D	9.062	21.178
1037	9.062	21.030
1036U	9.062	20.962
1036D	9.062	20.961
1034U	9.062	20.924
1034D	9.062	20.921
1032U	9.062	20.885
1032S	9.938	20.885
1032D	19.000	20.885
1031U	19.000	20.710
1031D	19.000	20.710
20	19.000	20.575
18U	19.000	20.494
18D	19.000	20.494
16	19.000	20.354
15	19.000	20.153
12U	19.000	19.910
11	19.000	19.907
10D	19.000	19.907
7	19.000	19.672
6	19.000	19.517
5	19.000	19.369
4	19.000	19.190
3	19.000	19.069
1030	19.000	18.989
1027U	19.000	18.890
1027D	19.000	18.847
1026	19.000	18.755
1025	19.000	18.612
1024	19.000	18.510
1023	19.000	18.293
1022	19.000	18.198
1021	19.000	17.938
1020	19.000	17.925
1019	19.000	17.482
1018	19.000	17.458

1017U	19.000	17.359
1017D	19.000	17.359
1016	19.000	17.359
1015	19.000	17.274
1014	19.000	17.276
1013	19.000	17.227
1012	19.000	17.178
1010	19.000	17.101
1009	19.000	17.083
1008	19.000	17.054
1007	19.000	17.008
1006	19.000	16.926
1005	19.000	16.851
1003	19.000	16.776
1002	19.000	16.747
1001	19.000	16.760

Existing with 3 x 2m box culvert
21 cumecs

label	flow	stage
1048	18.500	24.883
1047	18.500	24.534
1046	18.500	24.261
1045	18.500	23.917
1044	18.500	23.523
1043	18.500	23.359
1042	18.500	23.279
1041	18.500	23.242
1040U	18.500	22.825
1040M	18.500	22.781
1040D	18.500	22.709
51	18.500	22.511
50	18.500	22.298
48	18.500	22.145
46	18.500	21.982
1039A	18.500	21.465
1039T	2.500	21.465
1039B	21.000	21.465
1038U	21.000	21.349
1038S	10.213	21.349
PIPE1	10.213	21.345
PIPE2	10.213	21.276
PIPE3	10.213	21.192
PIPE4	10.213	21.107
PIPE5	10.213	21.023
1038D	10.787	21.349
1037	10.787	21.187
1036U	10.787	21.108
1036D	10.787	21.101
1034U	10.787	21.066
1034D	10.787	21.055
1032U	10.787	21.017
1032S	10.213	21.017
1032D	21.000	21.017
1031U	21.000	20.836
1031D	21.000	20.833
20	21.000	20.694
18U	21.000	20.622
18D	21.000	20.622
16	21.000	20.491
15	21.000	20.315
12U	21.000	20.080
11	21.000	20.075
10D	21.000	20.075
7	21.000	19.855
6	21.000	19.698
5	21.000	19.543
4	21.000	19.342
3	21.000	19.175
1030	21.000	19.093
1027U	21.000	18.989
1027D	21.000	18.949
1026	21.000	18.856
1025	21.000	18.712
1024	21.000	18.610
1023	21.000	18.393
1022	21.000	18.289
1021	21.000	18.021
1020	21.000	18.011
1019	21.000	17.546
1018	21.000	17.529

1017U	21.000	17.423
1017D	21.000	17.423
1016	21.000	17.429
1015	21.000	17.339
1014	21.000	17.345
1013	21.000	17.294
1012	21.000	17.240
1010	21.000	17.155
1009	21.000	17.137
1008	21.000	17.106
1007	21.000	17.055
1006	21.000	16.962
1005	21.000	16.874
1003	21.000	16.781
1002	21.000	16.744
1001	21.000	16.760

Existing with 3 x 2m box culvert
25.8 cumecs

label	flow	stage
1048	22.800	25.053
1047	22.800	24.736
1046	22.800	24.496
1045	22.800	24.190
1044	22.800	23.897
1043	22.800	23.795
1042	22.800	23.730
1041	22.800	23.640
1040U	22.800	23.142
1040M	22.800	23.034
1040D	22.800	22.957
51	22.800	22.739
50	22.800	22.524
48	22.800	22.408
46	22.800	22.278
1039A	22.800	21.853
1039T	3.000	21.853
1039B	25.800	21.853
1038U	25.800	21.769
1038S	10.758	21.769
PIPE1	10.758	21.765
PIPE2	10.758	21.672
PIPE3	10.758	21.578
PIPE4	10.758	21.484
PIPE5	10.758	21.390
1038D	15.042	21.769
1037	15.042	21.632
1036U	15.042	21.556
1036D	15.042	21.519
1034U	15.042	21.497
1034D	15.042	21.432
1032U	15.042	21.384
1032S	10.758	21.384
1032D	25.800	21.384
1031U	25.800	21.108
1031D	25.800	21.067
20	25.800	20.923
18U	25.800	20.872
18D	25.800	20.869
16	25.800	20.750
15	25.800	20.584
12U	25.800	20.316
11	25.800	20.305
10D	25.800	20.305
7	25.800	20.077
6	25.800	19.923
5	25.800	19.752
4	25.800	19.572
3	25.800	19.422
1030	25.800	19.332
1027U	25.800	19.219
1027D	25.800	19.189
1026	25.800	19.090
1025	25.800	18.938
1024	25.800	18.834
1023	25.800	18.626
1022	25.800	18.498
1021	25.800	18.207
1020	25.800	18.205
1019	25.800	17.694
1018	25.800	17.691

1017U	25.800	17.573
1017D	25.800	17.573
1016	25.800	17.591
1015	25.800	17.490
1014	25.800	17.508
1013	25.800	17.455
1012	25.800	17.392
1010	25.800	17.286
1009	25.800	17.270
1008	25.800	17.235
1007	25.800	17.177
1006	25.800	17.061
1005	25.800	16.942
1003	25.800	16.798
1002	25.800	16.736
1001	25.800	16.760

Existing with 3 x 2m box culvert
26.9 cumecs

label	flow	stage
1048	23.700	25.087
1047	23.700	24.779
1046	23.700	24.545
1045	23.700	24.246
1044	23.700	23.972
1043	23.700	23.880
1042	23.700	23.818
1041	23.700	23.713
1040U	23.700	23.213
1040M	23.700	23.086
1040D	23.700	23.009
51	23.700	22.787
50	23.700	22.574
48	23.700	22.465
46	23.700	22.340
1039A	23.700	21.924
1039T	3.200	21.924
1039B	26.900	21.924
1038U	26.900	21.842
1038S	10.956	21.842
PIPE1	10.956	21.838
PIPE2	10.956	21.741
PIPE3	10.956	21.643
PIPE4	10.956	21.546
PIPE5	10.956	21.449
1038D	15.944	21.842
1037	15.944	21.708
1036U	15.944	21.631
1036D	15.944	21.588
1034U	15.944	21.563
1034D	15.944	21.485
1032U	15.944	21.442
1032S	10.956	21.442
1032D	26.900	21.442
1031U	26.900	21.171
1031D	26.900	21.119
20	26.900	20.977
18U	26.900	20.929
18D	26.900	20.923
16	26.900	20.805
15	26.900	20.640
12U	26.900	20.363
11	26.900	20.351
10D	26.900	20.351
7	26.900	20.119
6	26.900	19.967
5	26.900	19.794
4	26.900	19.613
3	26.900	19.470
1030	26.900	19.386
1027U	26.900	19.273
1027D	26.900	19.245
1026	26.900	19.145
1025	26.900	18.991
1024	26.900	18.884
1023	26.900	18.677
1022	26.900	18.543
1021	26.900	18.246
1020	26.900	18.246
1019	26.900	17.725
1018	26.900	17.728

1017U	26.900	17.607
1017D	26.900	17.607
1016	26.900	17.627
1015	26.900	17.524
1014	26.900	17.545
1013	26.900	17.492
1012	26.900	17.427
1010	26.900	17.317
1009	26.900	17.301
1008	26.900	17.266
1007	26.900	17.207
1006	26.900	17.086
1005	26.900	16.961
1003	26.900	16.803
1002	26.900	16.734
1001	26.900	16.760

Existing with 3 x 2m box culvert
28.9 cumecs

label	flow	stage
1048	25.500	25.158
1047	25.500	24.869
1046	25.500	24.664
1045	25.500	24.397
1044	25.500	24.176
1043	25.500	24.106
1042	25.500	24.062
1041	25.500	23.917
1040U	25.500	23.549
1040M	25.500	23.216
1040D	25.500	23.130
51	25.500	22.891
50	25.500	22.684
48	25.500	22.586
46	25.500	22.470
1039A	25.500	22.072
1039T	3.400	22.072
1039B	28.900	22.072
1038U	28.900	21.995
1038S	11.302	21.995
PIPE1	11.302	21.991
PIPE2	11.302	21.887
PIPE3	11.302	21.784
PIPE4	11.302	21.680
PIPE5	11.302	21.577
1038D	17.598	21.995
1037	17.598	21.873
1036U	17.598	21.797
1036D	17.598	21.742
1034U	17.598	21.732
1034D	17.598	21.601
1032U	17.598	21.570
1032S	11.302	21.570
1032D	28.900	21.570
1031U	28.900	21.309
1031D	28.900	21.213
20	28.900	21.076
18U	28.900	21.031
18D	28.900	21.018
16	28.900	20.904
15	28.900	20.741
12U	28.900	20.447
11	28.900	20.433
10D	28.900	20.433
7	28.900	20.194
6	28.900	20.045
5	28.900	19.869
4	28.900	19.686
3	28.900	19.552
1030	28.900	19.478
1027U	28.900	19.365
1027D	28.900	19.340
1026	28.900	19.239
1025	28.900	19.082
1024	28.900	18.969
1023	28.900	18.770
1022	28.900	18.624
1021	28.900	18.316
1020	28.900	18.320
1019	28.900	17.776
1018	28.900	17.790

1017U	28.900	17.663
1017D	28.900	17.663
1016	28.900	17.690
1015	28.900	17.584
1014	28.900	17.611
1013	28.900	17.557
1012	28.900	17.489
1010	28.900	17.373
1009	28.900	17.358
1008	28.900	17.322
1007	28.900	17.262
1006	28.900	17.133
1005	28.900	16.999
1003	28.900	16.815
1002	28.900	16.730
1001	28.900	16.760

Existing with 3 x 2m box culvert
34.1 cumecs

label	flow	stage
1048	30.000	25.440
1047	30.000	25.250
1046	30.000	25.137
1045	30.000	24.977
1044	30.000	24.874
1043	30.000	24.843
1042	30.000	24.823
1041	30.000	24.589
1040U	30.000	24.441
1040M	30.000	23.550
1040D	30.000	23.491
51	30.000	23.242
50	30.000	23.009
48	30.000	22.874
46	30.000	22.784
1039A	30.000	22.411
1039T	4.100	22.411
1039B	34.100	22.411
1038U	34.100	22.336
1038S	12.698	22.336
PIPE1	12.698	22.331
PIPE2	12.698	22.200
PIPE3	12.698	22.069
PIPE4	12.698	21.939
PIPE5	12.698	21.808
1038D	21.402	22.336
1037	21.402	22.238
1036U	21.402	22.164
1036D	21.402	22.075
1034U	21.402	22.082
1034D	21.402	21.815
1032U	21.402	21.800
1032S	12.698	21.800
1032D	34.100	21.800
1031U	34.100	21.549
1031D	34.100	21.502
20	34.100	21.355
18U	34.100	21.321
18D	34.100	21.293
16	34.100	21.176
15	34.100	21.023
12U	34.100	20.680
11	34.100	20.656
10D	34.100	20.648
7	34.100	20.391
6	34.100	20.246
5	34.100	20.071
4	34.100	19.872
3	34.100	19.739
1030	34.100	19.675
1027U	34.100	19.573
1027D	34.100	19.548
1026	34.100	19.444
1025	34.100	19.298
1024	34.100	19.188
1023	34.100	18.997
1022	34.100	18.821
1021	34.100	18.489
1020	34.100	18.506
1019	34.100	17.917
1018	34.100	17.966

1017U	34.100	17.826
1017D	34.100	17.804
1016	34.100	17.851
1015	34.100	17.741
1014	34.100	17.781
1013	34.100	17.725
1012	34.100	17.650
1010	34.100	17.522
1009	34.100	17.509
1008	34.100	17.471
1007	34.100	17.409
1006	34.100	17.264
1005	34.100	17.113
1003	34.100	16.859
1002	34.100	16.719
1001	34.100	16.760

Existing with channel widened by 1m
18 cumecs

label	flow	stage
1048	15.800	24.680
1047	15.800	24.300
1046	15.800	23.978
1045	15.800	23.541
1044	15.800	23.081
1043	15.800	22.810
1042	15.800	22.661
1041	15.800	22.654
1040U	15.800	22.391
1040M	15.800	22.367
1040D	15.800	22.320
51	15.800	22.224
50	15.800	22.055
48	15.800	21.883
46	15.800	21.671
1039A	15.800	21.317
1039T	2.200	21.317
1039B	18.000	21.317
1038	18.000	21.278
1037	18.000	20.942
1036U	18.000	20.758
1036D	18.000	20.758
1034U	18.000	20.658
1034D	18.000	20.658
1032	18.000	20.552
1031U	18.000	20.419
1031D	18.000	20.419
20	18.000	20.357
18U	18.000	20.268
18D	18.000	20.268
16	18.000	20.100
15	18.000	19.887
12U	18.000	19.689
11	18.000	19.689
10D	18.000	19.689
7	18.000	19.480
6	18.000	19.361
5	18.000	19.242
4	18.000	19.103
3	18.000	19.016
1030	18.000	18.937
1027U	18.000	18.840
1027D	18.000	18.795
1026	18.000	18.704
1025	18.000	18.562
1024	18.000	18.459
1023	18.000	18.241
1022	18.000	18.151
1021	18.000	17.896
1020	18.000	17.882
1019	18.000	17.450
1018	18.000	17.422
1017U	18.000	17.326
1017D	18.000	17.326
1016	18.000	17.324
1015	18.000	17.242
1014	18.000	17.241
1013	18.000	17.194
1012	18.000	17.147
1010	18.000	17.075
1009	18.000	17.057

1008	18.000	17.029
1007	18.000	16.986
1006	18.000	16.910
1005	18.000	16.841
1003	18.000	16.773
1002	18.000	16.748
1001	18.000	16.760

Existing with channel widened by 1m
22 cumecs

label	flow	stage
1048	19.400	24.814
1047	19.400	24.470
1046	19.400	24.173
1045	19.400	23.764
1044	19.400	23.324
1043	19.400	23.074
1042	19.400	22.936
1041	19.400	22.918
1040U	19.400	22.607
1040M	19.400	22.561
1040D	19.400	22.515
51	19.400	22.409
50	19.400	22.223
48	19.400	22.079
46	19.400	21.914
1039A	19.400	21.619
1039T	2.600	21.619
1039B	22.000	21.619
1038	22.000	21.584
1037	22.000	21.285
1036U	22.000	21.096
1036D	22.000	21.068
1034U	22.000	20.965
1034D	22.000	20.939
1032	22.000	20.800
1031U	22.000	20.650
1031D	22.000	20.650
20	22.000	20.582
18U	22.000	20.514
18D	22.000	20.514
16	22.000	20.366
15	22.000	20.171
12U	22.000	19.972
11	22.000	19.967
10D	22.000	19.967
7	22.000	19.773
6	22.000	19.651
5	22.000	19.628
4	22.000	19.366
3	22.000	19.231
1030	22.000	19.144
1027U	22.000	19.037
1027D	22.000	18.999
1026	22.000	18.904
1025	22.000	18.760
1024	22.000	18.658
1023	22.000	18.443
1022	22.000	18.334
1021	22.000	18.061
1020	22.000	18.053
1019	22.000	17.578
1018	22.000	17.564
1017U	22.000	17.456
1017D	22.000	17.456
1016	22.000	17.464
1015	22.000	17.371
1014	22.000	17.380
1013	22.000	17.328
1012	22.000	17.272
1010	22.000	17.182
1009	22.000	17.164

1008	22.000	17.132
1007	22.000	17.080
1006	22.000	16.982
1005	22.000	16.886
1003	22.000	16.783
1002	22.000	16.743
1001	22.000	16.760

Existing with channel widened by 1m
25.8 cumecs

label	flow	stage
1048	22.800	24.945
1047	22.800	24.616
1046	22.800	24.351
1045	22.800	23.967
1044	22.800	23.559
1043	22.800	23.379
1042	22.800	23.286
1041	22.800	23.229
1040U	22.800	22.911
1040M	22.800	22.833
1040D	22.800	22.702
51	22.800	22.595
50	22.800	22.407
48	22.800	22.291
46	22.800	22.156
1039A	22.800	21.891
1039T	3.000	21.891
1039B	25.800	21.891
1038	25.800	21.856
1037	25.800	21.620
1036U	25.800	21.469
1036D	25.800	21.330
1034U	25.800	21.254
1034D	25.800	21.139
1032	25.800	21.013
1031U	25.800	20.846
1031D	25.800	20.839
20	25.800	20.756
18U	25.800	20.704
18D	25.800	20.704
16	25.800	20.565
15	25.800	20.383
12U	25.800	20.171
11	25.800	20.162
10D	25.800	20.162
7	25.800	19.961
6	25.800	19.835
5	25.800	19.693
4	25.800	19.538
3	25.800	19.417
1030	25.800	19.332
1027U	25.800	19.219
1027D	25.800	19.189
1026	25.800	19.090
1025	25.800	18.938
1024	25.800	18.834
1023	25.800	18.626
1022	25.800	18.498
1021	25.800	18.207
1020	25.800	18.205
1019	25.800	17.694
1018	25.800	17.691
1017U	25.800	17.573
1017D	25.800	17.573
1016	25.800	17.591
1015	25.800	17.490
1014	25.800	17.508
1013	25.800	17.455
1012	25.800	17.392
1010	25.800	17.286
1009	25.800	17.270

1008	25.800	17.235
1007	25.800	17.177
1006	25.800	17.061
1005	25.800	16.942
1003	25.800	16.798
1002	25.800	16.736
1001	25.800	16.760

Existing with channel widened by 1m
26.9 cumecs

label	flow	stage
1048	23.700	24.979
1047	23.700	24.654
1046	23.700	24.396
1045	23.700	24.018
1044	23.700	23.623
1043	23.700	23.457
1042	23.700	23.369
1041	23.700	23.301
1040U	23.700	22.977
1040M	23.700	22.883
1040D	23.700	22.751
51	23.700	22.645
50	23.700	22.461
48	23.700	22.355
46	23.700	22.228
1039A	23.700	21.971
1039T	3.200	21.971
1039B	26.900	21.971
1038	26.900	21.937
1037	26.900	21.718
1036U	26.900	21.575
1036D	26.900	21.417
1034U	26.900	21.355
1034D	26.900	21.199
1032	26.900	21.078
1031U	26.900	20.906
1031D	26.900	20.889
20	26.900	20.803
18U	26.900	20.754
18D	26.900	20.754
16	26.900	20.618
15	26.900	20.436
12U	26.900	20.219
11	26.900	20.208
10D	26.900	20.208
7	26.900	20.004
6	26.900	19.880
5	26.900	19.736
4	26.900	19.581
3	26.900	19.466
1030	26.900	19.386
1027U	26.900	19.273
1027D	26.900	19.245
1026	26.900	19.145
1025	26.900	18.991
1024	26.900	18.884
1023	26.900	18.677
1022	26.900	18.543
1021	26.900	18.246
1020	26.900	18.246
1019	26.900	17.725
1018	26.900	17.728
1017U	26.900	17.607
1017D	26.900	17.607
1016	26.900	17.627
1015	26.900	17.524
1014	26.900	17.545
1013	26.900	17.492
1012	26.900	17.427
1010	26.900	17.317
1009	26.900	17.301

1008	26.900	17.266
1007	26.900	17.207
1006	26.900	17.086
1005	26.900	16.961
1003	26.900	16.803
1002	26.900	16.734
1001	26.900	16.760

Existing with channel widened by 1m
28.9 cumecs

label	flow	stage
1048	25.500	25.043
1047	25.500	24.732
1046	25.500	24.484
1045	25.500	24.124
1044	25.500	23.771
1043	25.500	23.633
1042	25.500	23.557
1041	25.500	23.461
1040U	25.500	23.124
1040M	25.500	22.991
1040D	25.500	22.863
51	25.500	22.761
50	25.500	22.590
48	25.500	22.502
46	25.500	22.392
1039A	25.500	22.157
1039T	3.400	22.157
1039B	28.900	22.157
1038	28.900	22.125
1037	28.900	21.945
1036U	28.900	21.821
1036D	28.900	21.628
1034U	28.900	21.600
1034D	28.900	21.310
1032	28.900	21.196
1031U	28.900	21.018
1031D	28.900	20.981
20	28.900	20.892
18U	28.900	20.849
18D	28.900	20.847
16	28.900	20.713
15	28.900	20.533
12U	28.900	20.304
11	28.900	20.290
10D	28.900	20.290
7	28.900	20.083
6	28.900	19.961
5	28.900	19.814
4	28.900	19.658
3	28.900	19.549
1030	28.900	19.478
1027U	28.900	19.365
1027D	28.900	19.340
1026	28.900	19.239
1025	28.900	19.082
1024	28.900	18.969
1023	28.900	18.770
1022	28.900	18.624
1021	28.900	18.316
1020	28.900	18.320
1019	28.900	17.776
1018	28.900	17.790
1017U	28.900	17.663
1017D	28.900	17.663
1016	28.900	17.690
1015	28.900	17.584
1014	28.900	17.611
1013	28.900	17.557
1012	28.900	17.489
1010	28.900	17.373
1009	28.900	17.358

1008	28.900	17.322
1007	28.900	17.262
1006	28.900	17.133
1005	28.900	16.999
1003	28.900	16.815
1002	28.900	16.730
1001	28.900	16.760

Existing with channel widened by 2m
22 cumecs

label	flow	stage
1048	19.400	24.677
1047	19.400	24.270
1046	19.400	23.941
1045	19.400	23.536
1044	19.400	23.099
1043	19.400	22.836
1042	19.400	22.681
1041	19.400	22.671
1040U	19.400	22.440
1040M	19.400	22.399
1040D	19.400	22.313
51	19.400	22.250
50	19.400	22.075
48	19.400	21.893
46	19.400	21.652
1039A	19.400	21.297
1039T	2.600	21.297
1039B	22.000	21.297
1038	22.000	21.259
1037	22.000	20.949
1036U	22.000	20.795
1036D	22.000	20.795
1034U	22.000	20.715
1034D	22.000	20.715
1032	22.000	20.628
1031U	22.000	20.512
1031D	22.000	20.512
20	22.000	20.455
18U	22.000	20.363
18D	22.000	20.363
16	22.000	20.192
15	22.000	19.987
12U	22.000	19.811
11	22.000	19.808
10D	22.000	19.808
7	22.000	19.627
6	22.000	19.528
5	22.000	19.433
4	22.000	19.322
3	22.000	19.226
1030	22.000	19.144
1027U	22.000	19.037
1027D	22.000	18.999
1026	22.000	18.904
1025	22.000	18.760
1024	22.000	18.658
1023	22.000	18.443
1022	22.000	18.334
1021	22.000	18.061
1020	22.000	18.053
1019	22.000	17.578
1018	22.000	17.564
1017U	22.000	17.456
1017D	22.000	17.456
1016	22.000	17.464
1015	22.000	17.371
1014	22.000	17.380
1013	22.000	17.328
1012	22.000	17.272
1010	22.000	17.182
1009	22.000	17.164

1008	22.000	17.132
1007	22.000	17.080
1006	22.000	16.982
1005	22.000	16.886
1003	22.000	16.783
1002	22.000	16.743
1001	22.000	16.760

Existing with channel widened by 2m
25.8 cumecs

label	flow	stage
1048	22.800	24.793
1047	22.800	24.410
1046	22.800	24.095
1045	22.800	23.709
1044	22.800	23.292
1043	22.800	23.046
1042	22.800	22.900
1041	22.800	22.878
1040U	22.800	22.617
1040M	22.800	22.548
1040D	22.800	22.469
51	22.800	22.405
50	22.800	22.218
48	22.800	22.064
46	22.800	21.862
1039A	22.800	21.556
1039T	3.000	21.556
1039B	25.800	21.556
1038	25.800	21.523
1037	25.800	21.255
1036U	25.800	21.109
1036D	25.800	21.067
1034U	25.800	20.992
1034D	25.800	20.950
1032	25.800	20.837
1031U	25.800	20.711
1031D	25.800	20.711
20	25.800	20.645
18U	25.800	20.561
18D	25.800	20.561
16	25.800	20.403
15	25.800	20.202
12U	25.800	20.018
11	25.800	20.010
10D	25.800	20.010
7	25.800	19.826
6	25.800	19.720
5	25.800	19.612
4	25.800	19.504
3	25.800	19.414
1030	25.800	19.332
1027U	25.800	19.219
1027D	25.800	19.189
1026	25.800	19.090
1025	25.800	18.938
1024	25.800	18.834
1023	25.800	18.626
1022	25.800	18.498
1021	25.800	18.207
1020	25.800	18.205
1019	25.800	17.694
1018	25.800	17.691
1017U	25.800	17.573
1017D	25.800	17.573
1016	25.800	17.591
1015	25.800	17.490
1014	25.800	17.508
1013	25.800	17.455
1012	25.800	17.392
1010	25.800	17.286
1009	25.800	17.270

1008	25.800	17.235
1007	25.800	17.177
1006	25.800	17.061
1005	25.800	16.942
1003	25.800	16.798
1002	25.800	16.736
1001	25.800	16.760

Existing with channel widened by 2m
26 cumecs

label	flow	stage
1048	22.900	24.797
1047	22.900	24.414
1046	22.900	24.099
1045	22.900	23.714
1044	22.900	23.297
1043	22.900	23.052
1042	22.900	22.907
1041	22.900	22.884
1040U	22.900	22.622
1040M	22.900	22.551
1040D	22.900	22.475
51	22.900	22.410
50	22.900	22.224
48	22.900	22.071
46	22.900	21.872
1039A	22.900	21.570
1039T	3.100	21.570
1039B	26.000	21.570
1038	26.000	21.537
1037	26.000	21.272
1036U	26.000	21.128
1036D	26.000	21.080
1034U	26.000	21.007
1034D	26.000	20.959
1032	26.000	20.847
1031U	26.000	20.721
1031D	26.000	20.721
20	26.000	20.654
18U	26.000	20.571
18D	26.000	20.571
16	26.000	20.412
15	26.000	20.213
12U	26.000	20.029
11	26.000	20.020
10D	26.000	20.020
7	26.000	19.836
6	26.000	19.729
5	26.000	19.621
4	26.000	19.512
3	26.000	19.424
1030	26.000	19.342
1027U	26.000	19.229
1027D	26.000	19.199
1026	26.000	19.100
1025	26.000	18.948
1024	26.000	18.843
1023	26.000	18.635
1022	26.000	18.506
1021	26.000	18.215
1020	26.000	18.212
1019	26.000	17.700
1018	26.000	17.698
1017U	26.000	17.579
1017D	26.000	17.579
1016	26.000	17.597
1015	26.000	17.496
1014	26.000	17.515
1013	26.000	17.462
1012	26.000	17.398
1010	26.000	17.292
1009	26.000	17.275

1008	26.000	17.241
1007	26.000	17.183
1006	26.000	17.066
1005	26.000	16.946
1003	26.000	16.799
1002	26.000	16.736
1001	26.000	16.760

Existing with channel widened by 2m
26.9 cumecs

label	flow	stage
1048	23.700	24.825
1047	23.700	24.447
1046	23.700	24.135
1045	23.700	23.753
1044	23.700	23.343
1043	23.700	23.106
1042	23.700	22.962
1041	23.700	22.932
1040U	23.700	22.664
1040M	23.700	22.585
1040D	23.700	22.512
51	23.700	22.448
50	23.700	22.261
48	23.700	22.113
46	23.700	21.923
1039A	23.700	21.633
1039T	3.200	21.633
1039B	26.900	21.633
1038	26.900	21.602
1037	26.900	21.351
1036U	26.900	21.219
1036D	26.900	21.137
1034U	26.900	21.071
1034D	26.900	21.001
1032	26.900	20.891
1031U	26.900	20.762
1031D	26.900	20.762
20	26.900	20.694
18U	26.900	20.613
18D	26.900	20.613
16	26.900	20.456
15	26.900	20.259
12U	26.900	20.073
11	26.900	20.064
10D	26.900	20.064
7	26.900	19.878
6	26.900	19.770
5	26.900	19.658
4	26.900	19.549
3	26.900	19.463
1030	26.900	19.386
1027U	26.900	19.273
1027D	26.900	19.245
1026	26.900	19.145
1025	26.900	18.991
1024	26.900	18.884
1023	26.900	18.677
1022	26.900	18.543
1021	26.900	18.246
1020	26.900	18.246
1019	26.900	17.725
1018	26.900	17.728
1017U	26.900	17.607
1017D	26.900	17.607
1016	26.900	17.627
1015	26.900	17.524
1014	26.900	17.545
1013	26.900	17.492
1012	26.900	17.427
1010	26.900	17.317
1009	26.900	17.301

1008	26.900	17.266
1007	26.900	17.207
1006	26.900	17.086
1005	26.900	16.961
1003	26.900	16.803
1002	26.900	16.734
1001	26.900	16.760

Existing with channel widened by 2m
28.9 cumecs

label	flow	stage
1048	25.500	24.884
1047	25.500	24.508
1046	25.500	24.210
1045	25.500	23.841
1044	25.500	23.450
1043	25.500	23.249
1042	25.500	23.131
1041	25.500	23.077
1040U	25.500	22.808
1040M	25.500	22.718
1040D	25.500	22.606
51	25.500	22.545
50	25.500	22.359
48	25.500	22.229
46	25.500	22.065
1039A	25.500	21.808
1039T	3.400	21.808
1039B	28.900	21.808
1038	28.900	21.779
1037	28.900	21.587
1036U	28.900	21.488
1036D	28.900	21.288
1034U	28.900	21.233
1034D	28.900	21.096
1032	28.900	20.990
1031U	28.900	20.857
1031D	28.900	20.847
20	28.900	20.774
18U	28.900	20.701
18D	28.900	20.701
16	28.900	20.549
15	28.900	20.355
12U	28.900	20.163
11	28.900	20.150
10D	28.900	20.150
7	28.900	19.961
6	28.900	19.854
5	28.900	19.740
4	28.900	19.629
3	28.900	19.548
1030	28.900	19.478
1027U	28.900	19.365
1027D	28.900	19.340
1026	28.900	19.239
1025	28.900	19.082
1024	28.900	18.969
1023	28.900	18.770
1022	28.900	18.624
1021	28.900	18.316
1020	28.900	18.320
1019	28.900	17.776
1018	28.900	17.790
1017U	28.900	17.663
1017D	28.900	17.663
1016	28.900	17.690
1015	28.900	17.584
1014	28.900	17.611
1013	28.900	17.557
1012	28.900	17.489
1010	28.900	17.373
1009	28.900	17.358

1008	28.900	17.322
1007	28.900	17.262
1006	28.900	17.133
1005	28.900	16.999
1003	28.900	16.815
1002	28.900	16.730
1001	28.900	16.760

Existing with bed lowered d/s by 0.5m
13 cumecs

label	flow	stage
1048	11.400	24.497
1047	11.400	24.159
1046	11.400	23.825
1045	11.400	23.415
1044	11.400	22.948
1043	11.400	22.693
1042	11.400	22.571
1041	11.400	22.568
1040U	11.400	22.283
1040M	11.400	22.273
1040D	11.400	22.249
51	11.400	22.109
50	11.400	21.944
48	11.400	21.769
46	11.400	21.591
1039A	11.400	21.251
1039T	1.600	21.251
1039B	13.000	21.251
1038	13.000	21.206
1037	13.000	20.827
1036U	13.000	20.589
1036D	13.000	20.589
1034U	13.000	20.448
1034D	13.000	20.448
1032	13.000	20.277
1031U	13.000	20.061
1031D	13.000	20.061
20	13.000	19.859
18U	13.000	19.792
18D	13.000	19.792
16	13.000	19.635
15	13.000	19.413
12U	13.000	19.247
11	13.000	19.247
10D	13.000	19.247
7	13.000	19.049
6	13.000	18.951
5	13.000	18.870
4	13.000	18.766
3	13.000	18.694
1030	13.000	18.610
1027U	13.000	18.534
1027D	13.000	18.507
1026	13.000	18.425
1025	13.000	18.295
1024	13.000	18.194
1023	13.000	17.965
1022	13.000	17.897
1021	13.000	17.673
1020	13.000	17.652
1019	13.000	17.283
1018	13.000	17.231
1017U	13.000	17.155
1017D	13.000	17.155
1016	13.000	17.145
1015	13.000	17.079
1014	13.000	17.069
1013	13.000	17.030
1012	13.000	16.995
1010	13.000	16.946
1009	13.000	16.933

1008	13.000	16.913
1007	13.000	16.884
1006	13.000	16.839
1005	13.000	16.800
1003	13.000	16.766
1002	13.000	16.754
1001	13.000	16.760

Existing with bed lowered d/s by 0.5m
18 cumecs

label	flow	stage
1048	15.800	24.776
1047	15.800	24.413
1046	15.800	24.113
1045	15.800	23.750
1044	15.800	23.332
1043	15.800	23.122
1042	15.800	23.022
1041	15.800	23.006
1040U	15.800	22.639
1040M	15.800	22.610
1040D	15.800	22.576
51	15.800	22.405
50	15.800	22.229
48	15.800	22.102
46	15.800	21.980
1039A	15.800	21.706
1039T	2.200	21.706
1039B	18.000	21.706
1038	18.000	21.668
1037	18.000	21.333
1036U	18.000	21.068
1036D	18.000	21.052
1034U	18.000	20.879
1034D	18.000	20.873
1032	18.000	20.651
1031U	18.000	20.419
1031D	18.000	20.419
20	18.000	20.199
18U	18.000	20.153
18D	18.000	20.153
16	18.000	20.016
15	18.000	19.812
12U	18.000	19.628
11	18.000	19.628
10D	18.000	19.628
7	18.000	19.418
6	18.000	19.307
5	18.000	19.216
4	18.000	19.094
3	18.000	19.016
1030	18.000	18.937
1027U	18.000	18.840
1027D	18.000	18.795
1026	18.000	18.704
1025	18.000	18.562
1024	18.000	18.459
1023	18.000	18.241
1022	18.000	18.151
1021	18.000	17.896
1020	18.000	17.882
1019	18.000	17.450
1018	18.000	17.422
1017U	18.000	17.326
1017D	18.000	17.326
1016	18.000	17.324
1015	18.000	17.242
1014	18.000	17.241
1013	18.000	17.194
1012	18.000	17.147
1010	18.000	17.075
1009	18.000	17.057

1008	18.000	17.029
1007	18.000	16.986
1006	18.000	16.910
1005	18.000	16.841
1003	18.000	16.773
1002	18.000	16.748
1001	18.000	16.760

Existing with bed lowered d/s by 0.5m
25.8 cumecs

label	flow	stage
1048	22.800	25.055
1047	22.800	24.740
1046	22.800	24.503
1045	22.800	24.205
1044	22.800	23.927
1043	22.800	23.832
1042	22.800	23.769
1041	22.800	23.677
1040U	22.800	23.212
1040M	22.800	23.094
1040D	22.800	23.027
51	22.800	22.831
50	22.800	22.658
48	22.800	22.578
46	22.800	22.488
1039A	22.800	22.214
1039T	3.000	22.214
1039B	25.800	22.214
1038	25.800	22.169
1037	25.800	21.930
1036U	25.800	21.735
1036D	25.800	21.595
1034U	25.800	21.533
1034D	25.800	21.327
1032	25.800	21.176
1031U	25.800	20.929
1031D	25.800	20.911
20	25.800	20.676
18U	25.800	20.648
18D	25.800	20.648
16	25.800	20.533
15	25.800	20.362
12U	25.800	20.155
11	25.800	20.146
10D	25.800	20.146
7	25.800	19.936
6	25.800	19.800
5	25.800	19.673
4	25.800	19.530
3	25.800	19.417
1030	25.800	19.332
1027U	25.800	19.219
1027D	25.800	19.189
1026	25.800	19.090
1025	25.800	18.938
1024	25.800	18.834
1023	25.800	18.626
1022	25.800	18.498
1021	25.800	18.207
1020	25.800	18.205
1019	25.800	17.694
1018	25.800	17.691
1017U	25.800	17.573
1017D	25.800	17.573
1016	25.800	17.591
1015	25.800	17.490
1014	25.800	17.508
1013	25.800	17.455
1012	25.800	17.392
1010	25.800	17.286
1009	25.800	17.270

1008	25.800	17.235
1007	25.800	17.177
1006	25.800	17.061
1005	25.800	16.942
1003	25.800	16.798
1002	25.800	16.736
1001	25.800	16.760

Existing with bed lowered d/s by 0.5m
26.9 cumecs

label	flow	stage
1048	23.700	25.091
1047	23.700	24.787
1046	23.700	24.560
1045	23.700	24.273
1044	23.700	24.021
1043	23.700	23.939
1042	23.700	23.884
1041	23.700	23.774
1040U	23.700	23.349
1040M	23.700	23.171
1040D	23.700	23.097
51	23.700	22.893
50	23.700	22.724
48	23.700	22.651
46	23.700	22.567
1039A	23.700	22.299
1039T	3.200	22.299
1039B	26.900	22.299
1038	26.900	22.253
1037	26.900	22.036
1036U	26.900	21.857
1036D	26.900	21.700
1034U	26.900	21.664
1034D	26.900	21.386
1032	26.900	21.243
1031U	26.900	20.993
1031D	26.900	20.965
20	26.900	20.725
18U	26.900	20.702
18D	26.900	20.702
16	26.900	20.588
15	26.900	20.419
12U	26.900	20.204
11	26.900	20.193
10D	26.900	20.193
7	26.900	19.980
6	26.900	19.846
5	26.900	19.718
4	26.900	19.574
3	26.900	19.465
1030	26.900	19.386
1027U	26.900	19.273
1027D	26.900	19.245
1026	26.900	19.145
1025	26.900	18.991
1024	26.900	18.884
1023	26.900	18.677
1022	26.900	18.543
1021	26.900	18.246
1020	26.900	18.246
1019	26.900	17.725
1018	26.900	17.728
1017U	26.900	17.607
1017D	26.900	17.607
1016	26.900	17.627
1015	26.900	17.524
1014	26.900	17.545
1013	26.900	17.492
1012	26.900	17.427
1010	26.900	17.317
1009	26.900	17.301

1008	26.900	17.266
1007	26.900	17.207
1006	26.900	17.086
1005	26.900	16.961
1003	26.900	16.803
1002	26.900	16.734
1001	26.900	16.760

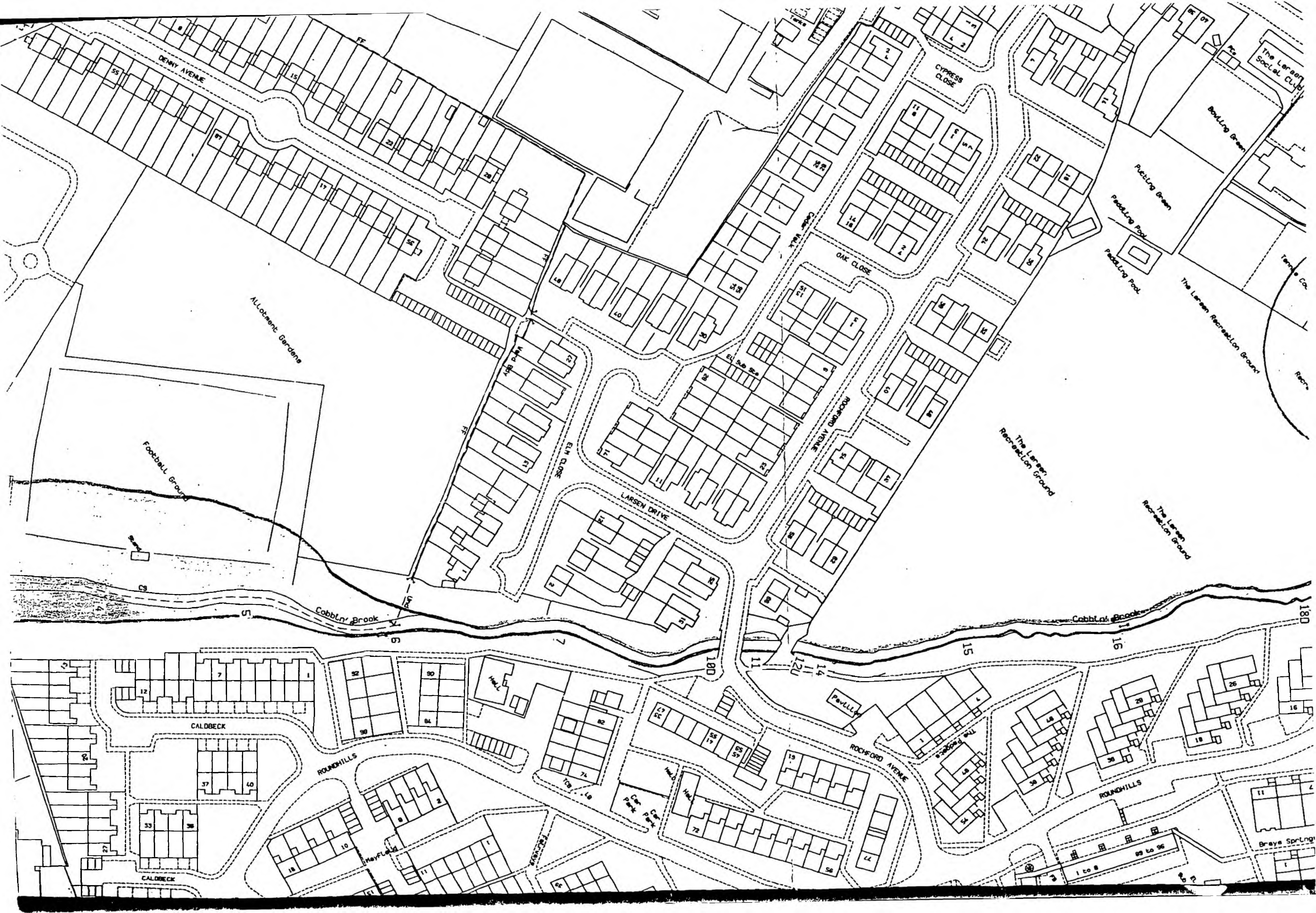
Existing with bed lowered d/s by 0.5m
28.9 cumecs

label	flow	stage
1048	25.500	25.195
1047	25.500	24.942
1046	25.500	24.780
1045	25.500	24.581
1044	25.500	24.436
1043	25.500	24.390
1042	25.500	24.363
1041	25.500	24.204
1040U	25.500	24.030
1040M	25.500	23.409
1040D	25.500	23.356
51	25.500	23.139
50	25.500	22.955
48	25.500	22.858
46	25.500	22.794
1039A	25.500	22.558
1039T	3.400	22.558
1039B	28.900	22.558
1038	28.900	22.518
1037	28.900	22.372
1036U	28.900	22.243
1036D	28.900	22.057
1034U	28.900	22.070
1034D	28.900	21.583
1032	28.900	21.442
1031U	28.900	21.106
1031D	28.900	21.055
20	28.900	20.814
18U	28.900	20.799
18D	28.900	20.799
16	28.900	20.687
15	28.900	20.518
12U	28.900	20.291
11	28.900	20.277
10D	28.900	20.277
7	28.900	20.058
6	28.900	19.927
5	28.900	19.797
4	28.900	19.652
3	28.900	19.549
1030	28.900	19.478
1027U	28.900	19.365
1027D	28.900	19.340
1026	28.900	19.239
1025	28.900	19.082
1024	28.900	18.969
1023	28.900	18.770
1022	28.900	18.624
1021	28.900	18.316
1020	28.900	18.320
1019	28.900	17.776
1018	28.900	17.790
1017U	28.900	17.663
1017D	28.900	17.663
1016	28.900	17.690
1015	28.900	17.584
1014	28.900	17.611
1013	28.900	17.557
1012	28.900	17.489
1010	28.900	17.373
1009	28.900	17.358

1008	28.900	17.322
1007	28.900	17.262
1006	28.900	17.133
1005	28.900	16.999
1003	28.900	16.815
1002	28.900	16.730
1001	28.900	16.760


PARKLANDS
Heathfield Nurseries
Tank
Drain
GALLEYHILL ROAD
Peatmoster Hill Nursery
Cobbly's Brook
1043
1044
1045
1041
1040U
1040M
1040D
BROOMSTICK HALL ROAD
BM 25.42m
BM 28.66m
23.140
23.650
24.438
SALLEYHILL ROAD
King Harold School
Tennis Courts
Sports Centre
The Governors
MINDFIELDS
SCALE 1:1250

BROOMSTICK HALL ROAD
EASTBROOK ROAD
ROUNTON ROAD
WOODBROOK GARDENS
ROSEBANK
GREENWOOD AVENUE
Car Park
The Green Man (PH)
The Larsen Social Club
Bowling Green
Putting Green
Paddling Pool
Cobbinsbank
The Larsen Recreation Ground
Tennis Courts
Playground
Cobbin's Brook
Eastbrook Hall
Conservative Club
Brayes Springs
BM 21.80m
22270
21690
22830
23.140
1031U
1031D
1032
1034U
1035U
1036D
1037U
1038
1039A
1039B
1039T
1040
1180
1181U
1181D
Und
RH
FF



DENNY AVENUE
Allotment Gardens
Football Ground
Cobbin' Brook
ELM CLOSE
LARSEN DRIVE
ROCHFORD AVENUE
OAK CLOSE
CYPRESS CLOSE
Cedar Walk
El Sub Sta
The Larsen Recreation Ground
The Larsen Social Club
Bowling Green
Putting Green
Paddling Pool
CALDBECK
ROUNDHILLS
Hayfield
Hall
Car Park
Pavilion
The Paddocks
Braye Springs
1 to 8
89 to 96